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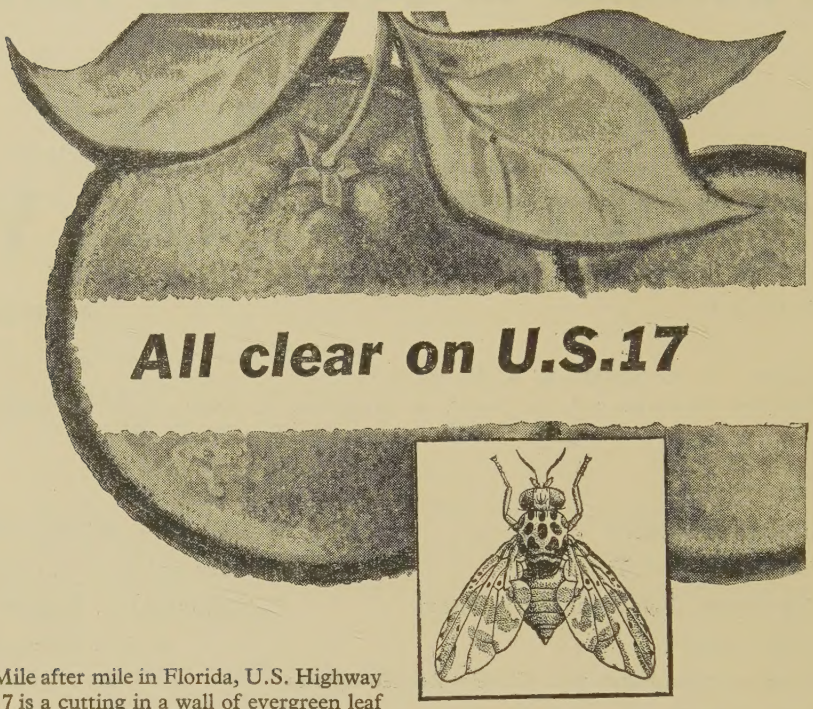

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EDITORIAL.

Retirement of Capt. H. S. Bushell, O.B.E., M.A.

Capt. H. S. Bushell retired on the 19th January 1959, after 39 years on the staff of the Commonwealth Institute of Entomology, for almost the whole of which he was Assistant Editor of the *Review of Applied Entomology* and responsible, under the Director, for its production. The nature of the *Review* was defined, and its policy initiated, by Sir Guy Marshall and Dr. S. A. Neave, and these have remained essentially unchanged to the present time, but it would be difficult to exaggerate the importance of the part played by Capt. Bushell in developing the *Review* so as to meet the demands made on it, particularly in recent years, by the progressively increasing range and complexity of its subject matter. The standards that he set himself and those associated with him have become a part of the tradition of the *Review*; his unique experience has also been available in a wider field through his membership of the Abstracting Services Consultative Committee from the time that this was set up, in 1948, by the Royal Society. The efforts of those concerned with scientific abstracting can rarely receive individual recognition, and it is fitting at this time to acknowledge in this *Review* the debt that it owes to Capt. Bushell's ability and to his long and devoted service.

Specifications and Methods of Analysis for certain Pesticides.—*Tech. Bull. Minist. Agric.* no. 1 (3rd edn.), x + 126 pp., 4 figs., 2 graphs, refs. London, H.M.S.O., 1958. Price 7*s*.

This edition of a bulletin on specifications and methods of analysis for toxic materials used in the control of agricultural pests and weeds in Britain resembles the first two in scope [*cf. R.A.E.*, A **40** 257, etc.], but a few revisions and additions have been made and the text is rearranged in three sections, of which the first and second deal, respectively, with specifications and methods of analysis, and the third with miscellaneous methods, apparatus and reagents used in analysis. An index has been added.

Geier (P.). **De la nuisibilité du carpocapse** (*Cydia pomonella* **L.): observations, remarques, suggestions.**—*Mitt. schweiz. ent. Ges.* **30** pt. 1 pp. 49–67, 5 figs., 24 refs. Berne, 1957. (With a Summary in English.)

The following is based on the author's summary. A method is proposed for assessing and expressing the damage caused by *Cydia pomonella* (L.) to apples and pears, having regard to the normal life-expectancy of the fruit at the time of infestation. Periodical counts of undamaged fruits from blossom to maturity allow an estimate to be made of the numbers of undamaged fruits the tree under survey would have produced if free from infestation. The difference between this and the recorded production of undamaged fruits shows the total damage. Relative damage is obtained by expressing the difference as a percentage of the total production. By this method, periodic losses can be estimated throughout the seasonal activity of the pest. Data are presented showing the variability in relative damage on unsprayed apple trees in an area bordering Lake Geneva, in Switzerland,

together with circumstantial evidence supporting the occurrence of correlations between intensity of damage and factors such as situation, variety, orchard composition and the individual characters of trees. The findings are discussed, and suggestions made for the planning of further research.

ČAPEK (M.) & ZWÖLFER (H.). *Apanteles murinanae* **nov. spec. (Braconidae, Hym.), ein neuer Parasit des Tannentriebwicklers.** [*A. murinanae*, sp.n., a new Parasite of *Choristoneura murinana*.]—*Mitt. schweiz. ent. Ges.* **30** pt. 2 pp. 119–126, 5 figs., 12 refs. Berne, 1957. (With a Summary in English.)

Descriptions are given of the adults of both sexes of *Apanteles murinanae*, sp.n., which was observed parasitising the larvae of *Choristoneura murinana* (Hb.) on silver fir [*Abies alba*] in central Slovakia in 1955. It is close to *Apanteles dioryctriae* Wlkn., characters distinguishing it from which are given, and is also recorded from the Vosges region of France [*cf. R.A.E.*, A **46** 466], the Black Forest of Germany, and central Moravia. *A. murinanae* appears to be more or less restricted to *C. murinana* and is possibly the only species of its genus parasitic on it, records of others being based on misidentification. Observations in the various localities showed that eggs are laid in the newly hatched *Choristoneura* larvae and that the parasite larvae overwinter in the hibernating second-instar hosts, resuming their development with the latter in spring, leave their hosts when these have reached the fifth instar, and spin cocoons between the needles. The cocoon stages last 12 days on the average, and the adults usually emerge shortly before those of *C. murinana* and any other parasites of it. Males were commoner than females in all localities investigated in 1956. The percentage parasitism by *A. murinanae* was low in all districts, which was probably due to secondary parasites that attacked the cocoon stages; a list of these is given [*cf. loc. cit.*]. The complex of parasites attacking *C. murinana* in Europe is compared with that associated with *C. fumiferana* (Clem.) on spruce and balsam fir [*Abies balsamea*] in Canada and the United States, and it is shown that the ecological niche occupied by *Apanteles murinanae* in the former is occupied by *A. fumiferanae* Vier. [*cf.* **36** 240] in the latter.

MAURIZIO (A.) & SCHENKER (P.). **Untersuchungen über die Ausscheidung bienengiftiger Pflanzenschutzmittel im Blütennektar.** [Investigations on the Output in the Nectar of Flowers of Chemicals used in Plant Protection that are poisonous to Bees.]—*Mitt. schweiz. ent. Ges.* **30** pt. 2 pp. 140–150, 25 refs. Berne, 1957. (With Summaries in French & English.)

Since fruit trees in Switzerland are now commonly sprayed against arthropod pests before or after blossoming, instead of during the dormant period, it is difficult to avoid spraying some trees in flower, so that honey bees may be affected; the use of systemic poisons increases the danger, since they may be present in the nectar of the flowers. Investigations were therefore carried out on the effect of recently-developed toxicants on bees and their ability to contaminate the nectar.

In the tests on bees, the toxicants were fed to the insects in sugar solution by means of a pipette, and mortality was observed at intervals for three days, from which LD50's were calculated. These showed that Isolan [1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate], Systox [diethyl 2-(ethylthio)ethyl phosphorothioate (demeton)] and Thiometon [O,O-dimethyl S-2-(ethylthio)ethyl phosphorodithioate] were relatively non-toxic and

diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], malathion, Methylisosystox [O,O-dimethyl S-2-(ethylthio)ethyl phosphorothioate (methyl-demeton-S)], parathion, and Phosphamidon [dimethyl 2-chloro-2-diethylcarbamoyl-1-methylvinyl phosphate] highly toxic.

The presence of toxicants in nectar was tested by spraying flowering borage (*Borago officinalis*) with 0·1 per cent. of the various materials [*cf. R.A.E.*, A **44** 176], collecting the nectar at intervals, and feeding it to bees as before. The results showed that when diazinon, parathion, Isolan and demeton were applied to buds, they did not enter the nectar or became non-toxic in it within 24 hours. When open flowers were sprayed, the nectar was toxic for 14–24 hours. Dipterex, Thiometon and malathion rendered the nectar toxic for several days, malathion having the most prolonged effect. Phosphamidon and methyl-demeton-S rendered it highly toxic, even when applied to buds, and the effect persisted for about a week. Tests are also described on the toxicity of the nectar to mosquito larvae.

Obrtel (R.). **Nosatčíci (*Apion* sp.), škůdci semenných kultur červeného jetele. I. část. Systematika, bionomie a škodlivost.** [Weevils (*Apion* spp.), Pests of Seed Crops of Red Clover. Part I. Systematics, Bionomics and Injuriousness.]—*Sborn. čsl. Akad. zeměd. Věd* Rostl. Výroba **3** (**30**) pt. 5 pp. 459–488, 20 figs., 2½ pp. refs. Prague, 1957. (With Summaries in Russian & English.)

The author gives a key to the 14 species of *Apion* that breed on clovers (*Trifolium* spp.), with notes on the distribution and abundance of the 13 that occur in Czechoslovakia. Of those that develop in the flower heads of red clover (*T. pratense*) there, the only ones of much importance are *A. apricans* Hbst. and *A. trifolii* (L.). These are injurious to seed crops, occur together and have similar bionomics. The sexually immature adults hibernate in forest borders, bushes or other shelter, but rarely in clover fields, to which they migrate in spring as soon as the morning frosts have ceased. They feed on the leaves and pollen cells in the anthers in April and May and pair during May and early June, and the females oviposit in May–July. Females of *A. trifolii* laid averages of 1–18 eggs each in the laboratory. The eggs are inserted into the buds in the green flower heads, usually 2–6 in each head, and hatch in 7–9 days. The larvae of the two species cannot be distinguished from each other. They feed on the flower parts, become full-fed in 17–20 days and pupate in cocoons in the clover heads. The pupal stage normally lasts 8–9 days, development being completed in 35–38 days for *A. apricans* and in 24–30 for *A. trifolii*. The adults emerge between the beginning of June and the beginning of September, feed on leaves for a period, their activity depending on weather, and then seek hibernation quarters. The loss of seed depends on the relation between the numbers and food-consumption of the larvae and the number of flowers per clover head, and ranges normally from 5 to 30 per cent., being greater in old than in new stands.

Křístek (J.). **Poznámky k bionomii a ke kontrole pilatky proužkované (*Pachynematus scutellatus* (Htg.)).** [Observations on the Bionomics and Control of *P. scutellatus*.]—*Acta Univ. Agric. Silv.* (C) 1957 pt. 4 pp. 273–291, 4 pls., 3 figs., 6 graphs, 15 refs. Brno, 1957. (With Summaries in Russian & German.)

An outbreak of *Pachynematus scutellatus* (Htg.) began in a spruce forest near Brno in 1947, and observations on the bionomics and control of this

sawfly were carried out there in 1952–56, with a view to the application of control measures. In this first part of a series in which the results are to be reported, observations on the adults and eggs are described, and the following is based on the author's summary of them. Adult emergence was very dependent on weather. In 1953, when thick snow covered the ground for some days during the emergence period, a few adults appeared in early May but the bulk did not appear until the middle of the month, when the temperature rose, emergence of males reaching a sharp peak on 16th May and that of females showing two peaks, on 16th and 18th May. In 1954, when conditions were more normal, emergence began about 20th–21st May, pursued a more even course, the peak being reached on 24th May for males and a few days later for females, and was completed by 30th May and 4th June, respectively. In the latter year, males lived for 12 days and females for 14. In the laboratory, the females laid half their eggs within 2½ days, and all of them in nine days. The egg stage lasted 4–8 days at 19–22°C. [66·2–71·6°F.], and unfertilised eggs hatched.

Vanková (J.). **Study of the Effect of** *Bacillus thuringiensis* **on Insects.**—*Folia biol.* **3** fasc. 3 pp. 175–182, 1 pl., 27 refs. Prague, 1957. (With a Summary in Russian.)

A virulent strain of *Bacillus thuringiensis* was isolated from diseased larvae of *Plodia interpunctella* (Hb.) in Czechoslovakia in 1952, and investigations on its pathogenicity to insects are described. The following is based on the author's summary of the work.

It was found that the crystalline inclusions that are formed in the cells of *B. thuringiensis* during sporulation and released at the same time as the spores could be well isolated from a mixture of spores, inclusions and vegetative débris by means of a density-gradient centrifuging technique, which is described. The proportion of inclusions to spores in the suspensions obtained ranged from 50:1 to 80:1. These inclusions had a strong insecticidal action. They had a toxic effect on caterpillars within a few hours of ingestion, causing immobilisation of the intestinal functions and reduced mobility, and caused the death of third-instar larvae of *Bombyx mori* (L.) and *Euproctis chrysorrhoea* (L.) (*phaeorrhoea* (Don.)) within one and five days, respectively. The spores alone caused septicaemia after a few days, but had no immediate toxic effect. A strain that had undergone degeneration and had lost the ability to form inclusions was not pathogenic to larvae of *E. chrysorrhoea*, *Lymantria dispar* (L.) or *Bombyx mori*. When inclusions from the virulent strain were added to the spores of the degenerate strain, mortality was the same as with the virulent strain. The bacillus also produced an antibiotic that was not identical with the inclusions.

Krywienczyk (J.), MacGregor (D. R.) & Bergold (G. H.). **Serological Relationship of Viruses from some Lepidopterous Insects.**—*Virology* **5** no. 3 pp. 476–480, 8 refs. New York, N.Y., 1958.

Most of the viruses pathogenic to insects are characterised by the formation of inclusion bodies in the nucleus or cytoplasm of infected cells. The polyhedral and capsular types can be distinguished by the size and shape of the inclusion bodies and the number of virus particles enclosed in them. Many species of Lepidoptera are attacked, but each virus is in general specific to one host. Since some representatives of each type are difficult to separate, particularly if they occur in closely related insects, and insect viruses have been found to be highly antigenic, the serological relations of

six polyhedral and two capsular viruses of Lepidoptera were investigated. Complement fixation was found to be the most suitable method, and the techniques used are described. The following is the authors' summary of the results.

It is shown that the polyhedral and capsular type of insect viruses belong serologically to two different groups. Viruses of either type from closely related insect hosts cross-react strongly, but the intensity of this reaction is much weaker with phylogenetically distant host species. Such reactions are not always reciprocal.

Simons (J. N.) & Coe (D. M.). **Transmission of Pseudo-curly Top Virus in Florida by a Treehopper.**—*Virology* **6** no. 1 pp. 43–48, 1 fig., 4 refs. New York, N.Y., 1958.

A virus disease of tomato with symptoms like those of curly-top is widely distributed in peninsular Florida and is referred to as pseudo-curly-top. It is readily transmitted by grafting from tomato to tomato, but cannot be transmitted mechanically. Investigations in 1954 showed that the virus also occurred in nightshade (*Solanum gracile*) and *Eupatorium* sp. round a tomato field, in which infection decreased progressively from the outermost rows towards the centre, but insects swept from the plants, mostly Cicadellids, failed to transmit the disease, as also did *Myzus persicae* (Sulz.). Negative results were also given by Cicadellids in 1956, but when tests were made with insects taken on infected nightshade in 1957, transmission to healthy nightshade and tomato was readily effected by a Membracid identified as *Micrutalis* sp. Uninfected examples of the latter caused no symptoms.

Harrison (B. D.). **Studies on the Behavior of Potato Leaf Roll and other Viruses in the Body of their Aphid Vector,** *Myzus persicae* **(Sulz.).**—*Virology* **6** no. 1 pp. 265–277, 1 graph, 12 refs. New York, N.Y., 1958.

The following is based on the author's summary. In the studies recorded, aphids were rendered infective by injection of virus-containing extracts or haemolymph from infected individuals into the ventral part of the abdomen [*cf.* also *R.A.E.*, A **45** 25]; the technique used is described. Apterae of *Myzus persicae* (Sulz.) were made infective by injection of 0·01–0·05 µl. of extracts from aphids that had fed on potato plants infected with leaf-roll or beet infected with the yellow-net virus, but the latter was transmitted much less readily by injection than the former and similar tests with the virus of beet yellows did not result in infection.

Under optimal conditions, half the treated aphids transmitted potato leaf-roll. Transmission seldom occurred within 20 hours of injection, but continued subsequently for up to 18 days. When aphids were made infective by feeding on diseased plants and extracts of non-infective aphids were then injected into them, they transmitted the virus during the following 20 hours as often as did infected aphids not subjected to injection. The infectivity of the extracts increased with the period of feeding on the source plants. When apterae of *M. persicae* were confined for 1–2 days on infected potato and subsequently transferred to turnip, their virus content appeared to decrease with increasing time on the latter, but infective extracts were obtained from aphids kept for four days on infected potato and for another four days on turnip. The explanation suggested is that the amount of leaf-roll virus acquired by the aphids increases with the feeding period on infected plants and that the virus passes through the haemolymph of the insects and is then transmitted back to plants, but that it does not multiply in the aphid.

Harrison (B. D.). **Ability of single Aphids to transmit both avirulent and virulent Strains of Potato Leaf Roll Virus.**—*Virology* **6** no. 1 pp. 278–286, 10 refs. New York, N.Y., 1958.

As part of an investigation on the mechanism of transmission of the potato leaf-roll virus by *Myzus persicae* (Sulz.), experiments were made to ascertain whether single aphids infected with one strain could acquire and transmit another. The following is based on the author's summary of the results.

A strain of potato leaf-roll virus causing mild symptoms in potato and *Physalis floridana* was more readily transmitted by *M. persicae* from these plants to *P. floridana* than was a virulent strain. *P. floridana* infected with the avirulent strain seemed immune to subsequent infection with the virulent strain. Single apterae of *M. persicae* that had fed on plants infected with the avirulent strain and had transmitted it to healthy plants subsequently acquired and transmitted the virulent strain, apparently as readily as did previously virus-free aphids. Most of the plants infected by means of single aphids carrying both virus strains seemed to contain only one of them, but both strains were recovered from some plants with intermediate-type symptoms.

Capps (H. W.). **An illustrated Key for Identification of Larvae of the Cotton-pest Species of** *Pectinophora* **Busck and** *Platyedra* **Meyrick (Lepidoptera, Gelechiidae).**—*Bull. ent. Res.* **49** pt. 4 pp. 631–632, 10 figs. London, 1958.

Platyedra vilella (Zell.), which was recorded for the first time in the United States in 1951 on hollyhock [*Althaea*] in New York [*cf. R.A.E.*, A **41** 287], appears to be established there, since adults were reared from larvae collected at the same place in 1952. In view of its importance as a pest of cotton elsewhere [*cf.* **18** 291; **21** 53; **26** 249] and the increased risks of the introduction of harmful species into new areas resulting from improved communications, a key is given permitting differentiation of the larvae of *P.* (*Pectinophora*) *gossypiella* (Saund.) and *P.* (*Pectinophora*) *scutigera* Hold., which are important pests of cotton in various parts of the world, *P.* (*Pectinophora*) *malvella* (Hb.), which has also been recorded from cotton [**22** 486; **26** 249], and *P. vilella*, as well as the larvae of these four species from all the others known to the author that feed on cotton in the field, together with diagrams illustrating setal and crochet patterns.

Milne (A.). **Biology and Ecology of the Garden Chafer,** *Phyllopertha horticola* **(L.). IV.—The Flight Season: Introduction, and general Aspects.**—*Bull. ent. Res.* **49** pt. 4 pp. 685–699, 5 figs., 5 refs. London, 1958.

In this part of a series on the bionomics of *Anomala* (*Phyllopertha*) *horticola* (L.) in Britain [*cf. R.A.E.*, A **45** 219, etc.], an account is given of observations in the Lake District during 1948–52 on the flight season of the adults [*cf.* **35** 165; **40** 71]. The following is based almost entirely on the author's summary of the results. The flight season begins in May or June, depending on soil temperature. When the population is low, it continues for 3–4 weeks, but when it is high, it may extend over 5–6 weeks, mainly because in heavily infested pastures there are bare patches [*cf.* **45** 220], in which warmer conditions cause development to be at least a week

in advance of that in the surrounding sward, but also because large populations may contain some exceptionally long-lived individuals. The flight season has two overlapping phases. In phase 1, the beetles swarm close over the grass sward from which they have emerged, but as the season progresses, this phase gradually gives way to phase 2, during the first half of which they swarm closely on bracken, hedges and trees surrounding the pasture and during the second they are confined to the bracken; in the absence of bracken, the whole phase is passed on hedges or deciduous trees. The earlier emerging beetles enter phase 2 before later ones have completed phase 1, and phase-1 activity consequently extends over the first two-thirds and phase 2 over the last two-thirds of the flight period.

Normal activity, comprising flying closely over or running or crawling on the vegetation, is governed by the weather, and both temperature and light are involved. Beetles are most active in warm, bright conditions and run and fly only when the sun is shining. In warm, bright-overcast conditions, they only crawl, and in cold, dull-overcast conditions, with or without wind or rain, they do not stir. Activity begins usually between 8 a.m. and 2 p.m. (G.M.T.) according to weather; the earliest recorded start was at 7 a.m. The first day of the flight season is usually marked by a short period of activity (1–2 hours) in the forenoon, even when the weather continues favourable into the late afternoon. As the days pass, the period lengthens until beetles are active up to about 4 p.m., the latest recorded finish being 4.30 p.m. The longest periods of activity (from 8 a.m. till 4 p.m.) occur when the sun shines all day after the first week of the flight season has passed. As the season draws to an end, the activity period shortens until on the last day it is one hour or less. In general, rather more of the activity period occurs before noon.

Curves illustrating the average population densities of active beetles throughout the day are described for both phases. During the period in which the phases overlap, the curves are complicated by a certain amount of movement in both directions between the grass sward and the bracken, trees or hedges. In addition, throughout phase 2 a few individuals (referred to as " bee-liners ") leave the bracken, flying high, straight and very fast.

For about the first week of the flight season, all beetles disappear into the sward at the end of the day's activity, but about three days before phase 2 starts, a growing fraction of each day's active population spends the whole night in full view on the sward surface, bracken fringe, hedges and trees. Passing the night on the sward ends with phase 1. Roosting on hedges and trees ends simultaneously with activity there, after the first half of phase 2. The bracken fringe alone is used to the end of the season. Between sunset and sunrise, 15–90 per cent. or more of the beetles fall from their roosting places to the ground owing primarily to a relaxation of their hold caused by falling temperatures. The beetles begin to feed when they stop spending the night below the surface of the sward. They feed from the end of the day's activity until 8 p.m. at the latest on the leaves, flowers and fruit on which they have come to rest for the night.

BANKS (C. J.). **Effects of the Ant,** *Lasius niger* **(L.), on the Behaviour and Reproduction of the Black Bean Aphid,** *Aphis fabae* **Scop.**—*Bull. ent. Res.* **49** pt. 4 pp. 701–714, 1 graph, 11 refs. London, 1958.

The following is almost entirely the author's summary. Cage experiments confirmed that, in the absence of natural enemies, populations of *Aphis fabae* Scop. attended on plants of broad bean (*Vicia faba*) by *Lasius niger* (L.), multiply more rapidly than similar but ant-free populations [*cf. R.A.E.*, A **46** 306]. The average increase in numbers recorded was about

one-third, the maximum being 70 per cent. No doubling or trebling of numbers as claimed in a paper previously noticed [**26** 195] was recorded. When the aphids were attended by ants, their behaviour in the excretion of honeydew, which is described, altered, and dispersal of the apterae from the young apical growth [*cf.* **39** 80] was considerably delayed. No significant differences were found between the numbers of nymphs produced by individual aphids from ant-visited and ant-free plants living on leaves of the same age, but the numbers were significantly affected by the age of the leaf or part of the plant on which the aphids had developed or were then feeding [**39** 198; **43** 89]. It is suggested that ant-attended aphid populations multiply more rapidly because most of the aphids feed for a much longer time on young plant tissue, where, presumably, their food supply is more nutritious.

Harris (W. V.) & Brown (E. S.). **The Termites of the Solomon Islands.** —*Bull. ent. Res.* **49** pt. 4 pp. 737–750, 2 pls., 14 figs., 16 refs. London, 1958.

This account of the termites of the Solomon Islands is based on collections made during 1954–56, chiefly on Guadalcanal and in coastal areas, and on specimens in the British Museum. The 12 species represented are listed, the numbers of records for each on coconut, in other outdoor habitats, and in buildings in the ten main islands and groups are shown in a table, and notes are given on their distribution, habitats, nests and occurrence on coconut palms and in buildings, together with a field key to their soldier castes. The principal species found in buildings are *Coptotermes grandiceps* Snyder [*cf. R.A.E.*, A **23** 280] and *C. pamuae* Snyder, which both attacked structural timbers in Guadalcanal and Malaita, and *Cryptotermes domesticus* (Hav.), which occurred in furniture in Guadalcanal and the Western Group and is of relatively minor importance, though a potential hazard. *Microcerotermes biroi* (Desn.), *Nasutitermes novarum-hebridarum* (Hlmgr.), *Schedorhinotermes marjoriae* (Snyder) and *S. solomonensis* (Snyder) were occasionally found in building timbers, but the first three primarily nested or occurred on coconut palms. Only one other species was associated with palms and no damage to them was observed. Methods of preventing damage to buildings are discussed, and measures applicable to local conditions are suggested; they comprise constructional methods and the impregnation of building timbers with suitable water-soluble poisons.

Blake (G. M.). **Diapause and the Regulation of Development in *Anthrenus verbasci* (L.) (Col., Dermestidae).**—*Bull. ent. Res.* **49** pt. 4 pp. 751–775, 1 pl., 13 figs., 17 refs. London, 1958.

The following is substantially the author's summary of this account of studies on the effects of temperature and relative humidity on the development of *Anthrenus verbasci* (L.), which is widely distributed as a pest of dried animal materials in temperate regions [*cf. R.A.E.*, A **30** 556; **42** 330].

The periods of incubation and pupation were shown to decrease with increase of temperature, the former from 54 days at 15°C. [59°F.] to 12 days at 30°C. [86°F.] and the latter from 89 days at 10°C. [50°F.] to nine days at 25°C. [77°F.]. Humidity differences had little effect [*cf.* **30** 556]. The larval development was exceptional in that under constant physical conditions in the laboratory there was a rhythmical onset of diapause, that is, development was regulated into one or more cycles, each

comprising a period of active growth followed by diapause. The length of the cycle under constant conditions was considerably less than a year. Larval development extended over one or two cycles, depending mainly on the temperature. At low temperatures of 15°C., development extended over two cycles; at 20°C. [68°F.] and above, only one cycle was needed, and at the intermediate temperature of 17·5°C. [63·5°F.], half the larvae required one cycle and half two. When the larvae developed under constant physical conditions with malnutrition, the rhythm of development was maintained, but the larvae tended to require an extra cycle for development, as compared with those receiving an adequate diet. At three sets of controlled alternating temperatures, ranging from 18 to 33°C. [64·4 to 91·4°F.], the rhythm of development was similar to that occurring under constant conditions at a temperature equal to the mean. The number of moults increased both with temperature and the time spent as a larva. At the unfavourably high temperatures of 30°C. and 35°C. [95°F.], larvae moulted an excessive number of times; one larva at 30°C. moulted 19 times after the fully grown stage was reached and, at 35°C. and 30 per cent. relative humidity, 13 of 20 fully grown larvae gradually decreased in length from about 5 mm. (when first exposed to 35°C.) to 2 mm., moulting several times in the process.

Under outdoor fluctuating conditions, the resting period in the cycle was extended, owing to the persistence of winter temperatures after the end of diapause. Active development began again in the spring when the temperature rose, and in this way the cycle was synchronised with the seasons into an annual rhythm of development. The life-cycle under outdoor conditions took one, two or more years to complete. Field populations, developing both in attics of houses and under more outdoor conditions, pupated in January–May, the time of pupation depending mainly on the temperature prevailing after the termination of diapause.

Diapause is of value to *A. verbasci* because it induces a rhythm in the life-cycle that synchronises with the rhythm of the seasons and ensures that the adults are present in May and June, when the maximum periods of sunshine favour flight and the preferred flowers are in bloom. The mechanism by which the rhythmical onset of diapause is controlled was not investigated.

Raw (F.) & Potter (C.). **Studies on the chemical Control of Wireworms (*Agriotes* spp.). II. The direct and residual Effects of BHC, DDT, Aldrin and Chlordane.**—*Bull. ent. Res.* **49** pt. 4 pp. 777–783, 23 refs. London, 1958.

In this part of a series on the control of wireworms (*Agriotes* spp.) in Britain [*cf. R.A.E.*, A **44** 93], an account is given of work in 1951–54 in a field at Rothamsted that was under grass for about 50 years before being ploughed up in November 1951 and sown to winter wheat and had a wireworm population of 2·5 million per acre in the spring of that year. The following is partly based on the authors' summary. The treatments tested were applied on 1st December 1951 and comprised a seed dressing of 20 per cent. γ BHC at 2 oz. per bushel seed and dusts of 3·5 per cent. crude BHC, 5 per cent. DDT, 1·78 per cent. aldrin and 5 per cent. chlordane drilled with the seed to give, respectively, 3·8–4 oz. γ BHC, 7·5 lb. technical DDT, 3·56 lb. technical aldrin and 5 lb. chlordane per acre. No benefits were observed from the BHC seed dressing [*cf.* **44** 94]. In the first year, when wireworm attack was light, yields from the plots treated with the aldrin, chlordane and BHC dusts were significantly greater than those from

the control plots and decreased in the order given. In the following year, when attack was heavier, the residues of these materials and DDT caused significantly increased yields in the same descending order of effectiveness, with DDT the least satisfactory, and in the third year a similar effect was observed with all the materials except DDT, BHC giving the best results. In the first and second years after application, wireworm populations in autumn were significantly lower in almost all the dusted plots than in the controls. Plant growth was significantly superior in plots treated with BHC, aldrin and chlordane to that in the controls in 1953, and almost so in the spring of 1954 in those treated with BHC, aldrin and DDT; in the following August, it was best in the plots treated with BHC, aldrin and chlordane. The ineffectiveness of DDT in the first year is attributed in part to its slowness of action and in the subsequent years to lack of the fumigant or systemic action possibly exerted by the other materials; evidence was obtained that it was relatively more effective than the others against the younger larvae and allowed a higher proportion of the larger, more injurious ones to survive.

Baker (C. B. M.) & Waines (R. A.). **Wireworm and Slug Damage to Ware Potatoes, 1954–56.**—*Plant Path.* **6** no. 4 pp. 115–122, 4 refs. London, 1957.

Surveys of main-crop potatoes have been made each autumn since 1947 in fields on representative farms throughout Britain to provide data for a pre-harvest estimate of ware production, and additional information on damage to the tubers by wireworms and slugs was obtained in 1954–56. It was found that about 75 per cent. of the damage already caused by wireworms could be detected by visual examination of freshly-lifted unwashed tubers, that wireworm damage is almost doubled during the period between the survey in September and harvest in October, and that it does not increase appreciably within the clamp or store, as had previously been suggested [*cf. R.A.E.*, A **27** 96]. The normal ware-crop production in England and Wales is about four million tons per year, and the estimated quantity of tubers damaged by wireworms in the three years under review varied from nearly 38,000 to over 90,000 tons; wireworm damage in Scotland was unimportant. The same tubers were rarely damaged by both wireworms and slugs, and damage by either or both in a normal year affected 1·3 per cent. of the total ware production throughout Britain, that by wireworms only averaging 1·22 per cent. Removal of damaged tubers is often economically justifiable in slightly infested crops, in which up to 0·8 ton of ware tubers per acre are affected, in good crop years, and in moderately infested ones, in which 0·8–1·99 tons per acre are affected, when tubers are scarce, but crops with two or more tons per acre infested can be used only for stock feed or industrial purposes. Severe damage by wireworms was less common in northern than in southern England, and there was a slight tendency for infestation to be heavy on the heavier soils and relatively light on chalk soils. In England and Wales, 12·5 per cent. of the fields on newly ploughed grassland and 6·3 per cent. of those on arable land were infested. The percentage of fields treated with insecticides against wireworms in the soil increased from 14 in 1955 to 18 in 1956, but the overall loss was greater in the latter year and the percentage of fields with signs of damage increased from five to six. Aldrin was mostly used, but earlier trials with this material showed that although applications at 2 lb. per acre normally reduce the damage caused by populations of less than 500,000 per acre to 4 per cent., they are occasionally ineffective. In 1955 and 1956, insecticide treatment

reduced damage from an average of 1 to 0·5 cwt. per acre, and it is concluded that the use of insecticides on a commercial scale cannot be recommended as a routine measure.

Stokes (B. M.). *Mayetiola dactylidis* **Kieffer in Cocksfoot Grass.**—*Plant Path.* **6** no. 4 pp. 127–130, 2 figs., 3 refs. London, 1957.

Mayetiola dactylidis Kieff., the larvae of which develop and pupate in the stems of cocksfoot (*Dactylis glomerata*), was common on this grass at Rothamsted in 1953. Examination of stems containing overwintered puparia showed few external signs of infestation, though there was a slight swelling at the base of the shoot when infestation was heavy; up to 25 puparia were found per shoot, between the leaf bases. When overwintered puparia were kept on damp peat in the insectary, emergence began about the second week of May from those collected between late January and late April 1953 or in March 1954, on 2nd June from those collected in the second half of April 1955, and on 19th July from those collected in late May or early June 1956, and continued without a peak until late August in 1954, early September in 1956 and late September in the other two years. Among newly emerged adults confined on *D. glomerata* in pots, pairing and oviposition took place on the same day. Eggs were laid in groups on the inner side of the leaf sheaths at the base of the plant, and the adults died within a day or two. In one of two breeding experiments begun on 4th June 1954, puparia, some recently formed, were observed on 13th August, additional ones were present on 22nd September, and 11 females emerged between 30th May and 15th June 1955, and in the other, 21 adults, of which 20 were females, emerged between 2nd and 15th June and between 27th August and 5th September. In another experiment, eggs were laid on 17th August 1954, puparia were present on 22nd September, and 21 females emerged in late August 1955. It is concluded that adults are present throughout the season, but that there is only one generation a year. No breeding took place when adult pairs were confined on oats, *Phleum pratense*, *Festuca pratensis*, *Lolium perenne* or *Alopecurus pratensis*, and an ovipositing female transferred to *Poa pratensis* laid no eggs on it, but resumed oviposition when returned to *D. glomerata*. Parasites identified as *Platygaster mayetiolae* Kieff. and *Semiotellus puncticollis* Thoms. were reared from field-collected puparia of *M. dactylidis* between 29th May and 11th September 1954; *P. mayetiolae* also emerged from puparia collected in Norfolk in 1950.

George (K. S.). **A Method for trapping Samples of small flying Insects.**—*Plant Path.* **6** no. 4 p. 132, 1 pl. London, 1957.

The trap described was designed for use in collecting adults of *Contarinia tritici* (Kby.) and *Sitodiplosis mosellana* (Géh.) during investigations in southern England on their abundance over wheat crops at different times; it permits large numbers of figures to be obtained when densities are low and during inconvenient activity periods. A cross-piece fixed at an adjustable height on a wooden upright has suspended from each end a wire frame accommodating three glass slides (3 × 1 in.) one above another; the slides are coated with adhesive on both sides, and the height of the cross-bar is adjusted periodically so that they remain at a constant height above the growing crop. On 11th, 15th, 19th and 20th June 1956 and subsequently each day from 22nd to 27th June, the numbers of midges found on 50 ears of wheat taken at random from each of two unsprayed plots during the hour

before sunset, when the midges are active, were compared with those caught on four traps in each plot during periods of 24 or 48 hours. No midges were found on the ears after 20th June and the usual number per plot taken before that date was three, though seven were found on one on 11th June. The numbers per plot caught on the traps were 0 on 11th and 15th June, but subsequently they ranged up to ten, the greatest numbers being taken between 24th and 27th June.

Shaw (M. W.). **Damage by Rosy Rustic Moth Larvae in Scotland, 1956.**—*Plant Path.* **6** no. 4 pp. 135–136, 1 pl. London, 1957.

Hydroecia (*Gortyna*) *micacea* (Esp.) is rarely of economic importance in Scotland but the larvae severely damaged cultivated crops in 1956, especially raspberry, *Iris*, rhubarb and potato. Outbreaks of the Noctuid on raspberry were confined to eastern Scotland, and apart from a record of similar damage at Dundee in 1947, injury to this crop was previously known only from Sweden [*cf. R.A.E.*, A **6** 149]. The larvae mined in the cortex of the stem, which they entered anywhere from the base to within a few inches of the top; they occasionally mined just below the epidermis and then retraced their path and left the stems. Infestation caused wilting of the apical leaves, which later became brittle and died. In south-eastern Scotland, 90 per cent. of a bed of 2,500 *Iris* plants were rendered useless by larval mining in the bulbs and young shoots. Damage to this plant was recorded previously in Angus in 1950 and Aberdeenshire in 1954. Larvae in various instars were found in both raspberry and *Iris*, and all damage to both crops was reported between 15th and 22nd June. In rhubarb crops at three places in Angus, 75 per cent. of the stalks were rendered unsaleable as a result of internal feeding tracks and exudation of sap from the lesions. Damage to this crop, on which serious injury appears to be rare, was previously recorded from London, Finland and Nova Scotia [**13** 235] in addition to Scotland [*cf.* **23** 79; **31** 82]. Potatoes were commonly damaged in many places, particularly in Kirkcudbrightshire, Ayrshire and western Perthshire. In south Kincardineshire, noticeable damage occurred on potatoes grown for seed tubers. Other crops attacked in eastern and south-eastern districts were strawberries, sugar-beet and *Gladiolus*.

Empson (D. W.). **Frit Fly and the Oat Panicle. I. The healthy Panicle.**—*Plant Path.* **6** no. 2 pp. 66–74, 1 pl., 16 refs. London, 1957. **II. Damaged Grain.**—*T.c.* no. 4 pp. 143–148, 6 refs.

Studies in Britain on the weight, kernel content and degree of blindness (arrested development due, possibly, to lack or failure of fertilisation) of grains in different parts of healthy oat panicles are described in the first part of this paper and on the effect of attack by the summer generation of *Oscinella frit* (L.) on the weight and kernel content of the grains and on the distribution of attack within and between the panicles in the second. It is concluded from the results that infestation of one grain is not followed by increased growth in uninfested ones in the same spikelet, as happens where one is blind, and that the weight of both husk and kernel of the uninfested grains may even be reduced. The lowest grain in the spikelet (main grain), which in a healthy panicle is the heaviest, was most often damaged, especially in light infestations, and the lowest grains in the panicle, which in healthy ones are the lightest, were the most heavily infested. Attack was probably most severe in small panicles, but there was no evidence of a constant relation between panicle size and grain weight.

The mean weight of damaged grains in crops with light infestations (about 5 per cent.) was about half that of healthy ones, and it was probably less in more heavily infested crops, because many grains may support more than one larva; the weight reduction was greater in the kernel than in the husk. In both husk and kernel of infested grains there was slightly more protein and slightly less carbohydrate than in healthy ones. The loss in weight in a sample composed of equal numbers of main and other grains from a lightly infested crop was about 7 per cent. for each 10 per cent. of attack where the grain was for use as stock feed, but the monetary loss per 10 per cent. of attack amounts to about 10 per cent., owing to the reduction in quality. When the grain is to be used for milling or seed, all infested grains are threshed out, and the loss is normally about 12 per cent. per 10 per cent. of attack, but the kernel content is unimpaired or even improved, since the main grains, in which the kernel content is lower than in the others, are most likely to be infested and hence removed; where infestation is heavy, the loss in weight is rather less in proportion.

Hunter-Jones (P.). **Laboratory Studies on the Inheritance of Phase Characters in Locusts.**—*Anti-Locust Bull.* no. 29, [2+] 32 pp., 6 figs., 27 refs. London, 1958.

The following is substantially the author's summary of this account of laboratory experiments carried out with *Schistocerca gregaria* (Forsk.) and *Locusta migratoria migratorioides* (R. & F.) to ascertain whether certain phase characters are inherited from one generation to the next and, if so, the importance of the inherited effect in relation to that of the degree of crowding or isolation. The experiments were designed to demonstrate the effects on the progeny of crowding or isolating the parent locusts as both hoppers (nymphs) and adults or as adults only, and the effects of crowding or isolating the progeny of crowded or isolated parents.

In both *Schistocerca* and *Locusta*, crowded parents generally produced dark hatchlings that were relatively heavy, and isolated parents produced pale, less heavy ones. The density of the parents as hoppers did not affect hatchling colour or weight, any effect on the hatchlings being due to the density of the parents as adults only. In *Schistocerca*, a pair of adults (a male and a female or two fertilised females per cage) produced dark, heavy hatchlings, and only completely isolated females, given males for a few hours only for mating, produced green hatchlings. This suggests that the relation between parental density and hatchling colour is associated with crowding, and not with the presence of a male as such, and this was confirmed by experiments with crowded virgin females which, reproducing parthenogenetically, produced dark hatchlings. In *Locusta*, the degree of crowding represented by single pairs was not sufficient to produce dark hatchlings. Isolation of *Locusta* parents for different periods of their adult life resulted in a reduction in weight of the F_1 hatchlings as the period of isolation increased, but there was little change in hatchling colour. When a mature female was isolated from a crowd, successive egg-pods laid by it produced, in general, successively paler hatchlings, but there was no change in hatchling weight.

When *Locusta* hatchlings from crowded and from isolated parents were reared at low and high densities, the difference in coloration persisted beyond the first instar. At both densities, the effect of rearing density tended in later instars to mask the inherited effect, so that by the fourth and fifth instars, hoppers reared at low density showed characters of phase *solitaria* and hoppers reared at high density those of phase *gregaria*, regardless of parental density treatment. Similar results were obtained with

Schistocerca, but the effect of rearing at high density masked the inherited effect much sooner, so that by the second instar the hoppers showed characters typical of phase *gregaria*, regardless of parental density. There was much greater variation in *Schistocerca* than in *Locusta* in the extent to which the effect of rearing at low density masked that of parental density. The progeny of *Locusta* parents invariably passed through five nymphal instars, but in *Schistocerca* the progeny of crowded parents had five instars while many of the progeny of isolated parents had six, regardless of rearing density. This tendency was correlated with hatchling weight, the heavier hatchlings passing through five instars and the lighter ones six.

The morphometrics of the adults of both species were affected by both rearing density and parental density. Single pairs of *Schistocerca* adults (a male and a female) yielded fewer eggs per pod than females completely isolated. Since the average number of pods laid per female was not affected by adult density, isolated females laid a higher total number of eggs than females of single pairs.

Stower (W. J.), Popov (G. B.) & Greathead (D. J.). **Oviposition Behaviour and Egg Mortality of the Desert Locust** (*Schistocerca gregaria* **Forskål) on the Coast of Eritrea.**—*Anti-Locust Bull.* no. 30, [2+] 33 pp., 5 pls., 6 figs., 1 col. fldg. map, 1 fldg. table, 4 refs. London, 1958.

Greathead (D. J.). **A new Species of** *Systoechus* **(Dipt., Bombyliidae), a Predator on Egg-pods of the Desert Locust,** *Schistocerca gregaria* **(Forskål).**—*Ent. mon. Mag.* **94** no. 1124 pp. 22–23. London, 1958.

The following is based almost entirely on the authors' summary of the first paper. Oviposition behaviour in females of *Schistocerca gregaria* (Forsk.) in the gregarious phase was studied at a place on the coastal plain of Eritrea between 24th February and 12th March 1954 and an account of the finding [*cf.* also next abstract] is given, together with a general description of the habitat. Most of the females had already oviposited when the observations were begun, but the behaviour of the rest was probably representative. A section of the egg field, 1/16 sq. mile in area, was surveyed, and the distribution of egg-pods in it was examined in relation to various components of the environment. It is concluded that vegetation cover, size of patches of bare soil and soil compaction all influenced the choice of oviposition sites and the degree of grouping observed. The denser vegetation was avoided; bare areas and softer soil were generally favoured. Further localisation of laying may have been brought about by temperature, light and soil-moisture patterns and by topography. However, all these factors combined were insufficient to explain completely the high degree of grouping, and it appears that gregarious behaviour by the adults also contributed to it. Egg mortality was studied during the period of incubation, and a numerical assessment was made of the hopper population likely to arise from the eggs laid. On the day of hatching, the site was sprayed to kill the hoppers, and the number of hoppers was determined from counted samples. Fair agreement was found between the two assessments. The Calliphorid, *Stomorhina lunata* (F.), was by far the most important mortality factor, destroying 15·5 per cent. of the eggs. Some eggs were destroyed by larvae identified as those of a Bombyliid described in the second paper from adults of both sexes as *Systoechus aurifacies*, sp. n., and some by an unidentified Sarcophagid larva that fed in egg-pods already attacked by *Stomorhina* or *Systoechus*. In addition, 10·9 per cent. of the eggs were non-viable. In spite of these losses, the total population

of hoppers that hatched in the area studied was estimated at some 40 million, which represents an increase of about 20-fold.

In the second paper, *S. aurifacies* is recorded from Eritrea and Arabia and is stated to be the second species of its genus found preying on the egg-pods of *Schistocerca gregaria* in East Africa [*cf. R.A.E.*, A **38** 353].

Popov (G. B.). **Ecological Studies on Oviposition by Swarms of the Desert Locust** (*Schistocerca gregaria* **Forskål**) **in eastern Africa.**— *Anti-Locust Bull.* no. 31, [2+] 70 pp., 14 pls., 18 figs., 43 refs. London, 1958.

The following is almost entirely the author's summary. The behaviour of swarming adults of *Schistocerca gregaria* (Forsk.) during reproduction was studied in relation to environmental conditions at some 30 sites in Eritrea [*cf.* preceding abstract], Ethiopia, Somalia and Kenya. The main component activities of this behaviour are pairing, copulation, probing, digging and laying. The patterns of oviposition resulting from the environmental and the behaviour factors were investigated. The settling of maturing and mature swarms is unrelated to the suitability of the site for laying. However, settling frequently appears to be associated with ecotone belts and mosaic vegetation [*cf. R.A.E.*, A **46** 370, etc.], where a wider range of conditions is available than in areas with more uniform vegetation and topography. The attraction to such areas may be visual, or through the effect of the associated microclimate. The selection of laying sites after the swarm has settled begins with marching, which begins soon after copulation has occurred [*cf.* **43** 384]. At first the selection is indirect, through the combined effects of temperature, vegetation and topography. In general, the females prefer the warmer and more open sites, and the probing and digging which precede oviposition begin in them. The selection is then influenced directly by the conditions of the soil. A dry, soft, sandy surface soil is preferred to a moist, compact one; the level of moisture below the surface is unimportant to a depth of about 6 cm., but at greater depths there is selection in favour of the higher moisture levels [*cf.* **29** 342]. Unless the whole egg-pod (not including the froth-plug) can be embedded in the moist soil at the time of laying, oviposition does not take place. The pattern of the environment thus influences oviposition and, generally speaking, the more uniform the environment, the more uniform the distribution of egg-pods.

Laboratory experiments were undertaken to test and elucidate some of the conclusions drawn in the field, particularly with regard to the influence of soil moisture. Oviposition occurred more frequently in moist sand covered with a layer of dry sand than in sand that was moist throughout. In sand that was dry throughout, digging occurred, but no laying. When the level of moisture was 8 cm. below the surface, laying still occurred occasionally, the egg-pod being deposited wholly within the moist layer, even though this involved extension of the abdomen to a depth of some 14 cm. below the surface. When the moisture level was deeper than about 8 cm., oviposition did not take place. Experiments in which the sand was moistened with medicinal liquid paraffin or a solution of sodium chloride instead of water led to the conclusion that the locust is capable of distinguishing sand moistened with water from sand moistened with the other liquids. The disturbance of sand by the penetration of the abdomen as far as a layer of moisture causes the moisture level to rise appreciably in the immediate vicinity; after the initial penetration, therefore, the moisture is more readily available, and this effect is cumulative when a succession of layings occurs in approximately the same place.

Abnormal oviposition occurs in the field and in the laboratory, eggs being deposited irregularly on or above the surface of the soil. It is usually associated with unfavourable environmental conditions, particularly dryness of soil to depths greater than the length of the fully extended abdomen. In a few cases, however, failure to oviposit normally could not be wholly ascribed to unsuitability of the environment, but no alternative causes are at present known. Laboratory experiments suggested that females ready to lay could delay laying for about 72 hours, but not longer. Laying by adults in swarms is usually associated with the formation of groups. While the grouping is influenced to a great extent by the environment, it is probably also due to gregariousness, since it occurs even under completely uniform conditions. Groups are formed by females of the same physiological age and of equal readiness to accept the group environment. Other females, though possibly attracted to the group, will not remain with it if they are not ready to lay.

Various methods were tested for surveying egg-fields. These included transects, quadrats, and lattice and random sampling. None was wholly satisfactory. It is suggested that a better method might be to divide the egg-field beforehand into units differentiated by their ecological characteristics and to sample each unit independently, basing the size of the samples on the variation found within each unit. A table indicating the type of laying that may be expected in a variety of environments is provided.

Gannon (N.) & Bigger (J. H.). **The Conversion of Aldrin and Heptachlor to their Epoxides in Soil.**—*J. econ. Ent.* **51** no. 1 pp. 1–2, 1 graph, 8 refs. Menasha, Wis., 1958.

In view of reports of the conversion of aldrin and heptachlor to their respective epoxides, dieldrin and heptachlor epoxide, in animals [*cf. R.A.E.*, A **46** 99], tests were made in Illinois in 1954–56 in which the insecticides were disked into the soil of fields at 1–10 and 1·5–15·2 lb. per acre, respectively, in the spring and soil samples taken and examined for aldrin, dieldrin, heptachlor and heptachlor epoxide in the autumn of the same or a subsequent year. Aldrin and heptachlor were separated from their presumed epoxides in extracts of the soil by means of chromatographic columns and all four analysed by specific colorimetric methods; the epoxides were also subjected to bioassay by a method using *Musca domestica* L. [**40** 167]. The results showed that epoxidation of both compounds had occurred. Aldrin was converted to dieldrin more rapidly than heptachlor to heptachlor epoxide, and most of the prolonged toxicity to soil-inhabiting insects recorded for aldrin must be due to the dieldrin produced, since the latter considerably exceeded the former in amount in almost all the plots. The quantities of heptachlor remaining generally exceeded the quantities of epoxide found, but the epoxide is probably of importance in controlling soil insects, as tests indicated that it is the more toxic to insects. It is therefore concluded that epoxidation of these insecticides in soil is advantageous, increasing both toxicity and residual effect.

Gannon (N.) & Decker (G. C.). **The Conversion of Heptachlor to its Epoxide on Plants.**—*J. econ. Ent.* **51** no. 1 pp. 3–7, 6 graphs, 7 refs. Menasha, Wis., 1958. **The Conversion of Aldrin to Dieldrin on Plants.**—*T.c.* pp. 8–11, 5 graphs, 10 refs.

In studies in Illinois on the rate of disappearance of insecticide residues on growing crops, highly significant disparities were observed between the

results given by total-chlorine and specific methods of analysis for residues of aldrin and heptachlor. Since these compounds have been shown to be converted to their respective epoxides, dieldrin and heptachlor epoxide, in both animals and soil [*cf.* preceding abstract, etc.], similar conversion on plants was suspected, and accounts are given in these two papers of experiments carried out to verify this. The insecticides were applied to lucerne at 1 and 5 lb. per acre in emulsion sprays, and plant samples were taken at intervals for extraction and analysis. Similar tests were later made with maize and soy beans, to verify the possibility of conversion on other crops, and the materials were applied at more than 25 lb. per acre to soy beans to secure sufficient material, with a minimum of plant contaminants, for qualitative infra-red analysis. The methods of separation and analysis used are described. The latter comprised analysis for total organic chloride, specific colorimetric and paper chromatographic analyses, bioassay with flies [*Musca domestica* L.] and comparison of infra-red spectrograms obtained from the residues on soy beans treated at the high rate with those of recrystallised aldrin, dieldrin, heptachlor and heptachlor epoxide, and the results obtained confirmed that both heptachlor and aldrin are converted to their epoxides on all three plants. After the applications of heptachlor and aldrin at 1 lb. per acre, the contents of the original compounds in the residues progressively decreased, while that of heptachlor epoxide and dieldrin increased during the first day and then decreased. More heptachlor epoxide and dieldrin than parent compound was present 2–3 days after application, and the two epoxides persisted at levels above 0·1 part per million for 25 days, as compared with 13 and 8 days, respectively, for heptachlor and aldrin.

Young (W. R.) & Rawlins (W. A.). **The Persistence of Heptachlor in Soils.**—*J. econ. Ent.* **51** no. 1 pp. 11–18, 5 figs., 12 refs. Menasha, Wis., 1958.

The following is based on the authors' summary. The persistence of heptachlor in sandy loam, silt loam, silty clay loam and muck soil was investigated in New York State in 1953–55. Where heptachlor was incorporated into the soil of field plots at 2–4 lb. per acre, an average of 26 per cent. of the amount present after treatment, as determined by specific colorimetric analysis, persisted for at least 21 months. When it was thoroughly mixed into soils of the same types at rates of 2–4 lb. per acre in the laboratory and the treated soils exposed to the weather in metal cylinders sunk into the ground, an average of 53 per cent. of the amount applied persisted for the same period. Differences in persistence between soil types were not significant, owing to wide variability among replicates.

In tests involving six weekly spray applications of heptachlor at less than 1 lb. per acre to the soil surface in late summer, only 31 per cent. of the total amount applied was present one week after the last application in the muck soil, 11 per cent. in the silty clay loam and 8 per cent. in the silt loam. Losses of heptachlor from the soil were less from an emulsion than from a wettable-powder spray, and losses from all soil types were greater from surfaces exposed to the sun than from shaded ones. Cultivation of the soil surface during the spray period apparently did not affect the persistence of the insecticide, and there was no evidence that it was leached from the soil or transformed into toxic degradation products or metabolites. It is concluded that heptachlor will not accumulate to dangerous levels in cultivated soils when applied as a soil treatment or as a foliage spray in the amounts recommended for insect control.

Floyd (E. H.), Powell (J. D.) & Ingram (J. W.). **Some Factors influencing the Infestation in Corn in the Field by the Rice Weevil.**—*J. econ. Ent.* **51** no. 1 pp. 23–26, 7 refs. Menasha, Wis., 1958.

Examination of maize from the various ecological areas in Louisiana revealed an average of more than 8 per cent. kernel injury, due largely to *Calandra* (*Sitophilus*) *oryzae* (L.), at harvest in 1955 and of nearly 22 per cent. in the stored grain ten months later. The actual percentages varied considerably, being generally greatest in the northern hill country and in the south, south-west and south-east, and very low in the Ouachita, upper Mississippi and Red River valleys. A comprehensive field experiment was carried out in 1956 on maize of a susceptible variety that was sown in late March, subjected to various protective treatments and harvested in mid-September. The results showed that bird damage to the husks was the main factor pre-disposing to infestation by *C. oryzae*; it was responsible for 63 per cent. of the total, damage due to the corn earworm [*Heliothis zea* (Boddie)] for about 15 per cent. and normal inherent characteristics of the maize for the remainder [*cf. R.A.E.*, A **41** 211–212, etc.]. Some of the plots were sprayed or dusted at intervals for several weeks from the beginning of silking (14th June), and examination at harvest showed that 1–5 applications of 2 lb. DDT with 1 U.S. gal. white oil in 25 U.S. gal. spray per acre or 1–2 applications of 30 lb. 10 per cent. DDT dust per acre did not significantly reduce damage by *Calandra*, whereas a spray of 1 lb. endrin with 1 U.S. gal. white oil in 25 U.S. gal. per acre directed to individual ears was extremely effective when applied on 6th July and gave almost complete control when applied on that date and again on 3rd August. The endrin treatments were made too late to control *H. zea*, but significantly reduced ear infestation by *Pyroderces rileyi* (Wlsm.), an important pest of maize in Louisiana. The DDT spray gave significant control of *H. zea* when applied three times as a simulated machine treatment, but was of practical value only when applied five times directly to the silks.

Rings (R. W.). **Types and seasonal Incidence of Plant Bug Injury to Peaches.**—*J. econ. Ent.* **51** no. 1 pp. 27–32, 2 figs., 13 refs. Menasha, Wis., 1958.

The work carried out in Ohio in 1953–56 on the damage caused by insects to peach fruits included tests in which adult Mirids were caged on peach and allowed to feed on fruits in various stages of development from bloom to harvest. The Mirids used comprised *Lygus lineolaris* (P. de B.), which was swept from clover and lucerne, and has long been known to damage peaches, and 14 species jarred from oak, hickory (*Carya*) or other trees, some of which were also known to damage them. They caused the same five types of injury as did the Pentatomids [*R.A.E.*, A **46** 434]. *L. lineolaris* caused blossom and fruit drop, cat-facing, scarring, water soaking and gummosis, and *Neolygus omnivagus* (Knight), from oak, and *N. caryae* (Knight), from hickory, all of these but blossom drop. *N. quercalbae* (Knight), from oak, produced cat-facing, scarring and gummosis, *N. canadensis* (Knight) cat-facing and gummosis, and *N. neglectus* (Knight) scarring and gummosis. Slight gummosis was caused by five other species, and no injury by the remaining four. Blossoms attacked by *L. lineolaris* withered and fell, and many of the fruits attacked by it between petal-fall and sepal-fall dropped. *L. lineolaris* and *Neolygus* spp. caused cat-facing of the fruits 14–35 days and scarring and gummosis 35–42 days after bloom. Water-soaked injury was produced 35–70 days after bloom, and gummosis was associated with most other types of injury, but also occurred alone 42–70 days after bloom.

Wright (J. M.) & Decker (G. C.). **Laboratory Studies of the Life Cycle of the Carrot Weevil.**—*J. econ. Ent.* **51** no. 1 pp. 37–39, 4 refs. Menasha, Wis., 1958.

Listronotus oregonensis (Lec.), which appeared in the carrot-growing area of northern Illinois in 1947, was reared at room temperature in the laboratory in 1951–52 for observations on its life-cycle under local conditions [*cf. R.A.E.*, A **47** 22]. Females caged with males oviposited readily in small cavities chewed in either the stems or roots of fresh carrots, but showed a preference for the roots. The eggs were transferred individually to punctures in fresh carrot slices, and the larvae were transferred to fresh slices every day until they became full-fed, when they were covered with moist soil and left to pupate. When the adults emerged, the process was repeated, and the overwintering adults were stored at 44°F. under moist soil.

Two generations developed each year. The adult females survived for long periods, lasting up to 428 days in the second generation. Five first-generation females that developed in 1951 oviposited 9–19 days after mating, and three that were produced in 1952 did so 17–34 days after, all in July–August, but one first-generation individual that mated in the autumn of 1951 did not oviposit until two days after it was removed from hibernation in mid-May 1952. Second-generation females did not oviposit before hibernating; two that developed in 1951 mated in mid-May 1952 and oviposited 43 days later. Up to 18 eggs were laid per cavity, the numbers being slightly higher in the stems than in the roots; the average per cavity was about 1·75–3·5 for both generations, but there was a direct correlation between the total number of eggs per female and the number per cavity. The larvae hatched in an average of 5·5–6 days and passed through five instars averaging about 2·5–3·5 days each in 1951 and 2–3 days each in 1952. The prepupal stage lasted 2–6 days, and the pupal stage averaged about 10·5 days for the first generation and 13·6 for the second, total development of the two generations requiring averages of 36·2 and 41·1 days in 1951 and 33·6 and 35·6 days in 1952. Owing to the length of the oviposition period, there was considerable overlapping of generations.

Pfrimmer (T. R.). **Insecticide Tests against the Boll Weevil and the Bollworm at Tallulah, La., in 1956.**—*J. econ. Ent.* **51** no. 1 pp. 41–43. Menasha, Wis., 1958.

Four experiments were carried out at Tallulah, Louisiana, in 1956, to evaluate recently developed insecticides for the control of *Anthonomus grandis* Boh. and *Heliothis zea* (Boddie) on cotton, on which no other pests were of economic importance. In the first three, all spray materials were emulsifiable concentrates except Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], which was in a 50 per cent. soluble powder, and sprays were applied at 4–6 U.S. gal. per acre. Applications were made at intervals of five days, and the quantities of insecticide given are those used per acre.

In the first experiment, in which sprays were applied 13–14 times between 30th July and 3rd October, 0·29 lb. endrin did not reduce the percentage of squares punctured by *Anthonomus*, but four mixtures of about 0·5 lb. DDT with other insecticides caused significant reductions; in these, 0·48 lb. EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate] or methyl-parathion was more effective than 2 lb. Dipterex, and 0·24 lb. Guthion [O,O-dimethyl S-(4-oxo-benzotriazino-3-methyl) phosphorodithioate] than EPN. All sprays caused significant reductions in the percentage of bolls injured by *H. zea*, and all but the Dipterex mixture significant increases in yield of seed cotton.

When applied 11–12 times between 31st July and 23rd September, in the second experiment, 0·5 lb. Thiodan [6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide] and 0·3 lb. endrin in sprays and 0·5 lb. heptachlor in granules did not reduce damage by *Anthonomus*, and 0·5 lb. Dow ET-15 [O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate] in a spray caused a reduction that was only just significant, whereas 0·52 lb. DDT with either 0·26 lb. Guthion or 2 lb. malathion in sprays and 13·8 lb. calcium arsenate or 0·67 lb. methyl-parathion in dusts reduced it very significantly. No differences in injury by *H. zea* or in yield were significant.

In the third experiment, dusts were applied 13 times between 18th July and 10th September; 0·5 lb. Thiodan and a mixture of 0·45 lb. endrin with 9 lb. sulphur gave no control of *Anthonomus*, and 15·2 lb. calcium arsenate and 0·37 lb. Guthion were significantly better against this insect than 0·8–0·95 lb. DDT with 3·81 lb. malathion, 0·8 lb. EPN or 0·4 lb. methyl-parathion. All gave significant control of *H. zea*, but methyl-parathion with DDT and endrin with sulphur were significantly better than calcium arsenate, Thiodan or Guthion, and malathion and EPN with DDT were intermediate in value. All but endrin with sulphur significantly increased the yield.

In the fourth experiment, Guthion at 0·53–0·54 lb. in 4–6 U.S. gal. emulsion spray per acre and at 0·56–0·62 lb. per acre in a dust, applied at intervals of 5, 7 or 10 days between 18th July and 19th September was compared with other treatments applied every five days. The Guthion spray at 5-day intervals was significantly more effective against *Anthonomus* than any other treatment but the Guthion dust at the same intervals, and the Guthion spray at 7-day intervals and the calcium-arsenate dust than any of the remaining treatments except the Guthion spray at 10-day intervals; sprays of 0·3 lb. endrin in 4–6 U.S. gal. or of 12·9 lb. wettable calcium arsenate in 10–12 U.S. gal. per acre caused significant reductions, but a dust of 0·37 lb. endrin with 7·37 lb. sulphur per acre did not. All treatments but the calcium-arsenate spray and the Guthion dust at 10-day intervals reduced injury by *H. zea*, and the endrin spray and dust were significantly more effective than the Guthion spray at 7-day intervals and the calcium-arsenate dust, but not than the other materials. All caused significant increases in yield, the Guthion sprays being slightly better than the Guthion dusts.

Norman (P. A.). **Severe T_3 Strain of Tristeza Virus transmitted by** *Aphis gossypii* **Glover.**—*J. econ. Ent.* **51** no. 1 p. 45, 2 refs. Menasha, Wis., 1958.

In Florida, *Aphis gossypii* Glov., *A. spiraecola* Patch and *Toxoptera aurantii* (Boy.) have been found capable of transmitting the mild T_1 and T_2 strains of tristeza virus to *Citrus*. In further tests, large colonies of *A. gossypii* were allowed to feed on seedlings of four varieties infected with the severe T_3 strain of the virus for 24 hours and were then transferred in groups of 300 to indicator plants and left on them for at least six hours. Symptoms characteristic of the T_3 strain appeared on 11 of the 16 plants in 94 days [*cf. R.A.E.*, A **44** 330].

Arthur (B. W.) & Casida (J. E.). **Biological and chemical Oxidation of Tetramethyl Phosphorodiamidic Fluoride (Dimefox).**—*J. econ. Ent.* **51** no. 1 pp. 49–56, 41 refs. Menasha, Wis., 1958.

The following is substantially the authors' summary of this account of comparative radiotracer experiments on the chemical oxidation and metabolism

of dimefox [bis(dimethylamino) fluorophosphine oxide], schradan and hexamethylphosphoramide (containing ^{32}P) in insects, mammals and plants. Dimefox and schradan became distributed in a similar manner among the organ systems and were excreted at identical rates in the urine and faeces of white rats, and both accumulated in the hindgut of *Periplaneta americana* (L.); in both cockroaches and rats, schradan was more stable to hydrolysis than dimefox. Dimefox was more readily absorbed by plants than was hexamethylphosphoramide, but was more rapidly volatilised and less stable within the plant tissues.

Within the insects, plants and mammals investigated, each of the three compounds was metabolised to oxidised derivatives that decomposed on treatment with acid to yield formaldehyde. The infra-red spectra of the non-hydrolytic biological metabolites showed a new infra-red absorption peak at 5·9 μ and a decreased height of absorption peaks at 2·94 and 6·18 μ. These changes in the infra-red spectra also occurred on oxidation of dimefox with peracetic acid, potassium permanganate and hydrogen peroxide. Dimefox and schradan were converted to more active anticholinesterase agents within insects, mammals and plants. The anticholinesterase activity of the oxidative intermediates was more closely associated with the groupings that yielded formaldehyde on treatment with acid than with the groupings responsible for the 5·9 μ absorption band. With all three compounds, one oxidative derivative was more and another less polar than the original phosphoramide. Because of the instability of certain oxidative intermediates and the lack of known compounds for comparison, the isomeric configuration of the derivatives could not be established. Except for the greater instability of dimefox and its derivatives, the metabolic intermediates appeared to be similar to those of schradan and hexamethylphosphoramide.

Ahmed (M. K.) & Casida (J. E.). **Metabolism of some organophosphorus Insecticides by Microorganisms.**—*J. econ. Ent.* **51** no. 1 pp. 59–63, 3 figs., 16 refs. Menasha, Wis., 1958.

The following is based mainly on the authors' abstract. As organic phosphorus insecticides frequently come into contact with the soil when applied for the control of insects, investigations were carried out on the metabolism of some of them by soil micro-organisms. A yeast, *Torulopsis utilis*, two bacteria, *Pseudomonas fluorescens* and *Thiobacillus thiooxidans*, and the green alga, *Chlorella pyrenoidosa*, were grown in pure cultures under aseptic conditions, the first two in a medium of glucose and yeast extract and the last two in mineral solutions. Emulsion concentrates of Thimet [O,O-diethyl S-ethylthiomethyl phosphorodithioate] and Am. Cyanamid 12008 [O,O-diethyl S-isopropylthiomethyl phosphorodithioate] were prepared by mixing with equal weights of Triton X-155 and emulsifying in sterilised distilled water, and these were introduced into the cultures to give concentrations of one part active compound per 1,000. Rates of hydrolysis and oxidation were measured.

Torulopsis and *Chlorella* reacted similarly, the compounds being apparently rapidly absorbed by them and then slowly released from the living and dead cells; the S-alkylthiomethyl derivatives were much more rapidly hydrolysed than the S-alkylsulphonylmethyl derivatives, and the latter only slightly faster than the S-alkylsulphinylmethyl compounds; in all cases, the phosphorodithioate sulphoxides were the most and the phosphorothiolate sulphides the least stable of the derivatives. *Chlorella* oxidised Thimet to the phosphorodithioate sulphoxide, which was very stable to hydrolysis but was slowly converted to the phosphorothiolate sulphoxide, with the formation of little if any phosphorothiolate sulphide or sulphones. Both *Torulopsis*

and *Chlorella* oxidised the sulphides to sulphoxides, but *Chlorella* was more effective in oxidising the phosphorodithioates to phosphorothiolates. Little if any oxidation was observed when parathion, Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], dimefox [bis(dimethylamino) fluorophosphine oxide] or schradan was introduced into cultures of *Chlorella*.

The two bacteria failed to oxidise Thimet, but hydrolysed it effectively; *Thiobacillus* could not utilise sulphur from the Thimet molecule.

Kantack (E. J.) & Knutson (H.). **Chemical Control Studies of the Wheat Curl Mite.**—*J. econ. Ent.* **51** no. 1 pp. 68–72, 8 refs. Menasha, Wis., 1958.

Investigations on the control of *Aceria tulipae* (Keifer), the vector of the virus causing wheat streak mosaic [*cf. R.A.E.*, A **46** 179], were carried out in Kansas in 1954.

In preliminary greenhouse spray tests with 30 chemical compounds and formulations, treatment with organic phosphates (0·25 lb. parathion, 0·65 lb. Phosdrin [dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate] or 0·25 lb. diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] per acre) gave high initial reductions in population, followed by increases after a few days, and treatment with chlorinated compounds (1 lb. dieldrin, 1–1·5 lb. chlorobenzilate [ethyl 4,4′-dichlorobenzilate] or 0·5 lb. endrin per acre) generally low initial reductions in population, followed by further reductions for up to 28 days; only light mineral seal oil at 5 U.S. gal. and Strobane [a chlorinated mixture of α-pinene isomers with a chlorine content of about 66 per cent.], diazinon and lindane [almost pure γ BHC] at 8, 1 and 3 lb. per acre, respectively, gave both high initial and long residual control, and all of them injured the wheat plants. In plots of autumn-sown wheat sprayed on 27th April or 10th May, 0·65 lb. Shell OS-1808 [diethyl 2-ethoxycarbonyl-1-methylvinyl phosphate] in 20 U.S. gal. spray per acre gave 90 per cent. control after two days, but no material was effective after 10–28 days, and in plots sprayed in autumn, soon after the seedlings had emerged, all but that receiving 0·4 lb. endrin in 1 U.S. gal. light oil per acre were infested after five weeks; after ten weeks, all plots were infested, the best control without plant injury being 54 per cent., given by endrin at 0·75 lb. per acre.

When systemic insecticides were applied to the seeds, all treatments retarded or reduced germination, 0·125 lb. demeton [diethyl 2-(ethylthio)-ethyl phosphorothioate], methyl-demeton [dimethyl 2-(ethylthio)ethyl phosphorothioate] or Am. Cyanamid 12008 [O,O-diethyl S-isopropylthiomethyl phosphorodithioate] in 4 lb. inert carrier per bushel seed doing so by less than 5 per cent. and 0·5 lb. of these and 0·125 lb. schradan, Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] and Am. Cyanamid 12009 [O,O-diethyl S-n-propylthiomethyl phosphorodithioate] by more. In further greenhouse tests of these materials, Am. Cyanamid 12008 and 12009 gave the best mite control for 1–7 weeks, applied either as the regular seed treatment or in granules temporarily attached to the seeds at the time of sowing. Seed treatment was generally more effective than drenching the soil with systemic insecticides, largely because the application of the drenches was delayed for three weeks to avoid damaging the germinating wheat. Better control was obtained with treated seed in the field than in the greenhouse after five weeks, but there was no control after ten weeks and counts in the following spring showed erratic results.

Large numbers of viruliferous mites were constantly liberated on the wheat in the field experiments, and wheat streak mosaic developed on most of the

plants, irrespective of treatment, and it was evident that the degree of mite control obtained was too low to reduce the spread of the disease.

Stanley (J. M.) & Dominick (C. B.). **Response of Tobacco- and Tomato-Hornworm Moths to Black Light.**—*J. econ. Ent.* **51** no. 1 pp. 78–80, 10 refs. Menasha, Wis., 1958.

Light-traps of two types were tested in three tobacco fields near Chatham, Virginia, during the tobacco-growing seasons of 1954–56, to study the response of *Protoparce sexta* (Joh.) and *P. quinquemaculata* (Haw.) to ultraviolet light and to evaluate the traps as a means of control. One was a mechanical trap, equipped with two 30-watt ultraviolet fluorescent lamps mounted horizontally and with baffles arranged to prevent the escape of the moths, and the other a suction trap equipped with a fan and four 15-watt ultraviolet fluorescent lamps mounted vertically. They were operated from the time of transplanting until after harvest and, although heavy infestations did not occur in any year, caught considerable numbers of adults of both species. Females represented only 17·9 per cent. of the total catch of *P. sexta*, but 46·1 per cent. of that of *P. quinquemaculata*. Counts of damaged plants in June–July and August–September, after the peaks of the first and second flight, indicated a slight reduction in damage where the traps were used, but the control afforded was not adequate, and it is concluded that traps of the types used cannot be considered as a practical means of reducing the damage [*cf. R.A.E.*, A **43** 320].

Stearns (L. A.). **Transient Insects in Delaware's Apple and Peach Plantings.**—*J. econ. Ent.* **51** no. 1 pp. 81–82, 6 refs. Menasha, Wis., 1958.

In continuation of earlier work [*R.A.E.*, A **45** 270–271], adhesive traps were hung in one peach and two apple orchards in Delaware from 10th April to late July 1956 and the insects caught on them identified. They comprised 4, 9, 20 and 2 species of Heteroptera, Homoptera, Coleoptera and Diptera, respectively, of which 28 were taken in the peach and 15 in the apple orchards. The importance and abundance of the different species are discussed. *Philaenus leucophthalmus* (L.) was the most numerous single species; it was taken from both apple and peach between 19th June and 26th July, and the typical injury that it causes to peach fruits [*cf. loc. cit.*] appeared during the third week of June.

Allen (H. W.). **Orchard Studies on the Effect of organic Insecticides on Parasitism of the Oriental Fruit Moth.**—*J. econ. Ent.* **51** no. 1 pp. 82–87, 1 map, 5 refs. Menasha, Wis., 1958.

The following is based largely on the author's abstract. Since laboratory and cage tests indicated that some of the common parasites of *Cydia* (*Grapholitha*) *molesta* (Busck) are susceptible to deposits of organic insecticides, the effects of several chlorinated-hydrocarbon and phosphorus insecticides on the moth and its parasites in New Jersey were studied by comparing rates of parasitism in several peach orchards in 1939–42, before such insecticides were used, and 1948–53, after they became common. Twig-infesting larvae of the first two generations were collected, and about 95 per cent. of the parasites reared from them were *Macrocentrus ancylivorus* Rohw. Some of the orchards investigated in 1948–53 did not receive insecticides, or were not treated with them until after the twig samples were taken, and

parasitism in these was as high as it had been in the earlier years. Parasitism was in general highest in orchards in which there was no exposure to insecticides and lowest in those heavily contaminated. Significant reductions in parasitism did not always follow severe exposure to insecticides, and the moth and parasite populations usually regained normal levels a few weeks after spraying was discontinued for the season. The average reduction in parasitism, even in orchards heavily exposed, was usually less than 50 per cent., but some instances of much greater reductions were observed. Only the sprays applied before 10th July directly affected parasites of the twig-infesting larvae. These included the early sprays of BHC, DDT or phosphorus compounds applied against *C. molesta* and the plum curculio [*Conotrachelus nenuphar* (Hbst.)] and similar sprays used in adjoining fields and orchards.

Swenson (K. G.). **Holly Bud Moth Control.**—*J. econ. Ent.* **51** no. 1 pp. 87–90, 13 refs. Menasha, Wis., 1958.

The following is largely the author's abstract. *Rhopobota naevana ilicifoliana* (Kearfott) (the holly bud moth) was introduced into British Columbia before 1923 [*cf. R.A.E.*, A **20** 67] and subsequently spread southward through Washington [*cf.* **20** 20] into Oregon, where it is now an important pest in holly plantings. Evaluation of insecticides for its control showed that organic phosphates are very effective against it. Malathion consistently provided excellent control when one spray was applied between the opening of the leaf buds and blossoming. Good control was also obtained with methoxy-DDT (methoxychlor), but DDT did not give consistent results. The difference between the results given by the organic phosphates and DDT may be due to tolerance of DDT in *R. n. ilicifoliana* or to an ovicidal effect of the phosphates. The results with methoxy-DDT support the first explanation.

Bartlett (B. R.) & Lloyd (D. C.). **Mealybugs attacking *Citrus* in California—a Survey of their natural Enemies and the Release of new Parasites and Predators.**—*J. econ. Ent.* **51** no. 1 pp. 90–93, 5 refs. Menasha, Wis., 1958.

A survey was made in 1953–58 of the natural enemies of the mealybugs that attack *Citrus* in California. These are *Planococcus* (*Pseudococcus*) *citri* (Risso), which is the most harmful and is the most abundant in zones of moderate humidity; *Pseudococcus maritimus* (Ehrh.), which is almost as injurious but requires high humidity for optimum development and the distribution of which overlaps that of the former in the intermediate zone and that of *P. adonidum* (L.), which is injurious in the damper coastal areas; and *P. gahani* Green, which is rare and overlaps the three others in its distribution. The most efficient predator found was in general *Cryptolaemus montrouzieri* Muls., but *Sympherobius* spp. and *Chrysopa* spp. were sometimes of importance in reducing dense infestations in certain areas. *Leucopis bella* Lw., *Coccinella californica* Mannh., *Hyperaspis lateralis* Muls. and *Scymnus sordidus* Horn were successively less effective. Ten species of parasites were found [*cf. R.A.E.*, A **38** 326]; the mealybug species and stages attacked by them are shown in a table. Nine species of predators and ten parasites were introduced into California in 1948–56 and released against the mealybugs; their host preferences, the stages attacked and details of origin and release are given in another table. Only two,

Allotropa citri Mues. from China and *Anagyrus pseudococci* (Gir.) from Brazil, were recovered; both prefer *Planococcus citri*, but *Allotropa* also attacks *Pseudococcus adonidum* and *Anagyrus* all three others.

Young (M. R.) & Roussel (J. S.). **The Effects of Temperature on the Efficiency of Insecticides applied topically to Boll Weevils differing in Susceptibility to Chlorinated Hydrocarbon Insecticides.**—*J. econ. Ent.* **51** no. 1 pp. 93–100, 7 graphs, 23 refs. Menasha, Wis., 1958.

Experiments were carried out in Louisiana in the autumn of 1956 on the responses to endrin, toxaphene and malathion of adults of *Anthonomus grandis* Boh. of a strain from cotton at St. Joseph that was resistant to chlorinated-hydrocarbon insecticides [*cf. R.A.E.*, A **46** 344] and one from Baton Rouge that was normally susceptible to them. The insects were treated topically with acetone solutions of the insecticides or of mixtures of malathion with endrin (5:2) or toxaphene (1:4), kept with cotton squares at 60, 80 or 90°F. and suitable relative humidities (70, 50 and 50 per cent., respectively) and examined for mortality after 24, 48 and 72 hours.

Comparison of the LD50's showed that toxicity tended to increase with temperature, except for the mixtures of endrin and malathion against the resistant strain, where the trend was reversed. After 48 hours at 80°F., the LD50's for endrin were 2·47 and 0·18 and those for toxaphene 1,074 and 114·9 mg. per g. for the resistant and susceptible strains, respectively. At all temperatures, the LD50's for endrin after 72 hours were considerably greater for the resistant than for the susceptible strain [*cf. loc. cit.*]; those for toxaphene were much higher than those for endrin against both strains, though the difference between strains was less great, and they varied more with temperature. The results for the three treatments including malathion showed that this compound was more effective against the resistant than against the susceptible strain, indicating that susceptibility to it was controlled by a different mechanism from that to the chlorinated hydrocarbons. Against both strains, endrin and malathion together were antagonistic at 90°F., but showed a synergistic effect at 60 and 80°F., whereas toxaphene and malathion were antagonistic at 60°, but showed a synergistic effect at 80 and 90°F., so that the mechanism causing synergism and antagonism had different temperature coefficients of action for the two combinations. The fact that each strain responded differently to each of the three insecticides when kept at different post-treatment temperatures indicated that the materials had different modes of action, and the difference in the amount of insecticide required to control the susceptible strain as compared with the resistant one at different temperatures is further evidence of this. There were also indications that the strains differed in other physiological functions.

Hopkins (A. R.), Fye (R. E.) & Walker (R. L.). **Field Tests with Thimet and Bayer 19639 for Cotton-insect Control.**—*J. econ. Ent.* **51** no. 1 pp. 100–102. Menasha, Wis., 1958.

Investigations on the value of Thimet [O,O-diethyl S-ethylthiomethyl phosphorodithioate] and Bayer 19639 [O,O-diethyl S-2-(ethylthio)ethyl phosphorodithioate] for the control of insects attacking cotton early in the season were carried out in South Carolina in 1956.

In a small-plot test, seed treated with Thimet on carbon powder, or activated charcoal impregnated with Bayer 19639, was sown at 33 lb. per

acre on 19th April to give 1 lb. Thimet and 1, 2 or 3 lb. 19639 per acre, or Thimet granules were applied with the seed in the furrow at 1 and 2 lb. toxicant per acre. The seed treatments, but not the furrow treatments, caused significant reductions in plant stand. None of them affected fruiting, except that the heavier furrow treatment caused slight delay, or lint quality, and all reduced infestation by *Aphis gossypii* Glov. about four months after sowing, the two higher doses of 19639 being significantly better than the Thimet seed treatment. No control of *Anthonomus grandis* Boh. was obtained, and variations in yield could not be attributed to the insecticides. In a concurrent field-cage test, the treatments gave significant kill of overwintered adults of *A. grandis* on seedling cotton, but none on cotton that had begun to form squares.

In another test, cotton was sown on 26th April and 10, 20 or 30 lb. Thimet per acre was applied as side dressing in 2 per cent. granules on 25th May to plants that had received fertiliser with or without phosphorus. All treatments controlled the aphid for at least 2·5 months, but there were no significant differences in infestation by *A. grandis*, plant characteristics or yield.

Anderson (L. D.) & Atkins jr. (E. L.). **Toxicity of Pesticides to Honey Bees in laboratory and field Tests in southern California, 1955–1956.** —*J. econ. Ent.* **51** no. 1 pp. 103–108, 1 fig., 4 refs. Menasha, Wis., 1958.

In further laboratory tests in California of the toxicity of dusts containing recently developed toxicants to honey bees, carried out by the same technique as before [*cf. R.A.E.*, A **43** 414], 33 compounds, almost all of them insecticides, were compared with a standard dust of DDT. At the highest rate tested, ten, including Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate (dicaphthon)], Guthion [O,O-dimethyl S-(4-oxo-benzotriazino-3-methyl) phosphorodithioate], Dow ET-15 [O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate], DDVP [dimethyl 2,2-dichlorovinyl phosphate], Phosdrin [dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate], Am. Cyanamid 12008 [O,O-diethyl S-isopropylthiomethyl phosphorodithioate], Sevin (1-naphthyl N-methylcarbamate), and Am. Cyanamid 12009 [O,O-diethyl S-n-propylthiomethyl phosphorodithioate], were more toxic than DDT, their toxicity decreasing in the order named. The compounds less toxic than DDT included Trithion [O,O-diethyl S-p-chlorophenylthiomethyl phosphorodithioate], and Thimet [O,O-diethyl S-ethylthiomethyl phosphorodithioate], which were moderately toxic, and Karathane [2,4-dinitro-6-(1-methylheptyl)phenyl crotonate], Phostex [a mixture of bis(dialkyloxyphosphinothioyl)disulphides], Kelthane [1,1-bis(p-chlorophenyl)-2,2,2-trichloroethanol], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], Hercules AC-528 [2,3-p-dioxane S,S-bis(O,O-diethyl phosphorodithioate)], chlorbenside [p-chlorobenzyl p-chlorophenyl sulphide], methyl-chlorobenzilate [methyl 4,4′-dichlorobenzilate], and Holcomb 326 [O,O-diisopropyl N,N-diethylthiocarbamoyl phosphorodithioate] which were non-toxic or practically so. Sabadilla was non-toxic at dosages comparable to those used in *Citrus* groves, but toxic at rates used on vegetable crops. Studies of DDT, toxaphene and sulphur, alone and in various combinations in dusts, showed that DDT was moderately toxic to bees, but sulphur and toxaphene only slightly toxic. No synergistic effects were observed in the combinations.

In field tests with sprays, parathion proved highly toxic to honey bees, and its use on lucerne in flower is not recommended. Although malathion is

moderately toxic to bees, it appeared to be less so than parathion and, with proper timing of applications, it was used on lucerne in flower without serious losses. In similar circumstances, Trithion and Dipterex were harmless.

Levin (I.), Kugler (H. W.) & Barnett (H. C.). **An Automation System for Insectaries.**—*J. econ. Ent.* **51** no. 1 pp. 109–111, 3 figs. Menasha, Wis., 1958.

The authors describe and illustrate an apparatus designed to control the operation of various types of electrically driven insectary equipment automatically, according to an integrated 24-hour schedule. It was built for use at Washington in the rearing of exotic species of mosquitos, which involved complex use of air conditioners, humidifiers, fans and both incandescent and fluorescent lamps. In addition to turning equipment on and off after varying intervals, the apparatus was designed to dim and brighten lights to the lower and upper limits of their capacities according to a regular schedule.

Hays (K. L.). **The present Status of the Imported Fire Ant in Argentina.** —*J. econ. Ent.* **51** no. 1 pp. 111–112. Menasha, Wis., 1958.

Solenopsis saevissima richteri Forel is native to the subtropical and temperate climatic regions of South America, and its distribution and ecology in Argentina are briefly described. It has been observed to feed on germinating seeds, but is largely insectivorous and is generally considered beneficial because it destroys many harmful insects. No damage to vegetation has been observed, except by the building of mounds, which vary considerably in abundance in different regions, and no deaths of livestock from attack by the ants have been reported. Its natural enemies include another ant, *Labauchena daguerrei* Santschi, which lives on the body of the queen, eats part of the food brought by the workers and has been reported to feed on the eggs, so weakening but not destroying the colony, *Orasema* sp., which parasitises a few of the prepupae, and an unidentified Phorid.

Wene (G. P.). **Control of the Cabbage Looper on Cotton.**—*J. econ. Ent.* **51** no. 1 pp. 113–114, 1 ref. Menasha, Wis., 1958.

In the course of experiments on the control of the boll weevil [*Anthonomus grandis* Boh.] on cotton in the Lower Rio Grande Valley of Texas in 1956, observations were made on the effect of the insecticides on *Trichoplusia ni* (Hb.), which has recently become injurious to cotton in many areas [*cf. R.A.E.*, A **46** 444]. Dusts were applied at 20 lb. and sprays at 4·5 U.S. gal. per acre with hand apparatus on 19th, 22nd, 25th and 29th June and 3rd and 9th July. Counts of the larvae on samples of 100 leaves, made a few hours after the last application, showed that dusts containing 5 per cent. DDT with either 5 per cent. methyl-parathion or 2·5 per cent. methyl-parathion and 2·5 per cent. heptachlor and sprays affording 1 lb. DDT with either 2·5 lb. malathion or 1·25 lb. malathion and 1 lb. toxaphene per acre gave at least 90 per cent. reduction and dusts of toxaphene, alone or with methyl-parathion or DDT or of Thiodan [6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide] with DDT and a spray of toxaphene and DDT at least 75 per cent.; a spray of heptachlor, malathion and DDT gave only 66 per cent. reduction, and a combination of DDT and heptachlor in either spray or dust was ineffective. It is concluded that *T. ni* can be controlled by the use of suitable insecticides in programmes against *A. grandis*.

Wene (G. P.) & Schuster (M.). **Boll Weevil Control with Heptachlor Granules.**—*J. econ. Ent.* **51** no. 1 p. 114. Menasha, Wis., 1958.

An experiment on the early-season control of the boll weevil [*Anthonomus grandis* Boh.] by means of granules containing 2·5 per cent. heptachlor was carried out in the Lower Rio Grande Valley of Texas in 1957 in a field in which infestation had for the previous three years been localised in the southern part for the first month, until square infestation reached 50 per cent., after which it spread to the rest. The granules were applied at 33, 50 and 35 lb. per acre on 15th and 29th May and 10th June, respectively, to plots established in the south, centre and north of the field. The first application was made when the weevils emerged from hibernation and moved into the field and only the plots in the south showed appreciable infestation. The percentage infestation increased about equally in these, reaching 50 per cent. by the end of May, after which there were further increases on the untreated plants but decreases on the treated ones. The weevil spread to the other plots about the end of May, but the infestation reached only low levels in the north of the field and was well controlled in the centre on the treated plots.

DeBach (P.), Kennett (C. E.) & Pence (R. J.). **Species of *Thysanus* as primary Parasites.**—*J. econ. Ent.* **51** no. 1 pp. 114–115, 3 refs. Menasha, Wis., 1958.

It has sometimes been assumed that all species of *Thysanus* are hyperparasitic, but at least two, *T. merceti* (Malen.) and *T. thoreauini* (Gir.), have been reared as primary parasites of *Hemiberlesia rapax* (Comst.) on *Citrus* and *H. lataniae* (Sign.) on avocado in California, where parasitism by them is common and efficient.

Observations showed that the eggs of *T. merceti* are deposited, unattached, in the body cavities of mature females of *H. rapax*. The larvae developed internally, without preventing the production of eggs by the host, until they were nearly half-grown (about 5–6 days at 80°F.), after which they migrated slowly through the host derm and fed externally, pupating outside the reduced host body but under the protective scale cover. The adults, all of which were females, emerged after about 25 days at room temperature and fed on the Coccids by drilling through their coverings. *T. merceti* was itself parasitised by *Marietta mexicana* (How.).

T. merceti is often the only parasite attacking *H. rapax* on *Citrus* and sometimes affords a high degree of parasitism. Commercially injurious infestations of this Coccid are rare, but *T. merceti*, *T. thoreauini* and relatively small numbers of *Aspidiotiphagus citrinus* (Craw) were shown to cause considerable reductions of a heavy infestation in a semi-abandoned grove in 1951–52, and this and other observations indicate that species of *Thysanus* are probably among the more important factors that keep *H. rapax* populations below the economic level on *Citrus* and other plants.

Hightower (B. G.). **Laboratory Study on the Effect of Thrips Infestation on the Height and Weight of Seedling Cotton.**—*J. econ. Ent.* **51** no. 1 pp. 115–116, 3 refs. Menasha, Wis., 1958.

Preliminary investigations on the damage caused to cotton by *Frankliniella tritici* (Fitch) and *F. fusca* (Hinds) were carried out in Texas in May 1956. Cotton seedlings grown in pots were infested with one insect per

plant when two days old and kept at temperatures of 80–87°F. and 50–90 per cent. relative humidity for two weeks, after which they were examined, weighed and measured. The cotyledons were extensively damaged on plants infested with *F. fusca* and completely destroyed on several, whereas only five of 30 plants infested with *F. tritici* were severely injured, though most of the cotyledons showed signs of feeding. In three tests, *F. tritici* reduced the average height of the plants by 7, 8 and 15 per cent. and the average weight by 22, 11 and 48 per cent.; in contrast, *F. fusca* reduced the height by 29, 30 and 27 per cent. and the weight by 57, 44 and 63 per cent. In the first two tests, the differences were significant between *F. fusca* and *F. tritici*, but not between *F. tritici* and no infestation, and in the third, they were significant between each thrips and no infestation, but not between the species of thrips.

Clark (R. C.) & Brown (N. R.). **Studies of Predators of the Balsam Woolly Aphid,** *Adelges piceae* **(Ratz.) (Homoptera: Adelgidae). III. Field Identification and some Notes on the Biology of** *Neoleucopis pinicola* **Mall. (Diptera: Chamaemyiidae).**—*Canad. Ent.* **89** no. 9 pp. 404–409, 8 figs., 4 refs. Ottawa, 1957.

In this third paper of a series on the predators of *Chermes* (*Adelges*) *piceae* Ratz. on balsam fir [*Abies balsamea*] in eastern Canada [*cf. R.A.E.*, A **46** 266], characters are given for the field determination of all stages of *Leucopis* (*Neoleucopis*) *pinicola* Mall., which occasionally preys on *C. piceae* there, together with notes on its bionomics and value in control. In New Brunswick, it commonly attacks *C.* (*Pineus*) *strobi* (Htg.), which occurs through most of the United States and southern Canada on *Pinus strobus*, *P. sylvestris* and *P. nigra*. The larvae feed on all stages of *C. piceae*, and those of the summer and overwintering generations are present, respectively, from June to early August and from about the end of July until the following June. Although very common, this predator appears to be of little importance in controlling *C. piceae*, probably owing to insufficient or improperly timed feeding. It is itself parasitised by two species of Hymenoptera and attacked by a Dermestid.

Smith (B. C.) & Coppel (H. C.). **Releases in North America and Reviews of Bionomics in Europe of Insect Predators of the Balsam Woolly Aphid,** *Adelges piceae* **(Ratz.) (Homoptera: Adelgidae).**—*Canad. Ent.* **89** no. 9 pp. 410–420, 16 refs. Ottawa, 1957.

The following is based largely on the authors' summary. During 1933–55, 11 species of insect predators were introduced from Europe into eastern Canada for trial against *Chermes* (*Adelges*) *piceae* Ratz. on balsam fir, *Abies balsamea* [*cf. R.A.E.*, A **45** 379; **46** 266]. The numbers of each species released, with the areas in and the years in which they were liberated, are shown in a table and the life-histories, habits and natural enemies of each in Europe are reviewed. Of the six species from England, only *Leucopis* (*Neoleucopis*) *obscura* Hal. [**42** 263; **46** 267] has become established; it now occurs over most of the area infested by *C. piceae* in New Brunswick, Nova Scotia and Prince Edward Island. Of six introduced from continental Europe [*cf.* **42** 199], *Cremifania nigrocellulata* Czerny [*cf.* **45** 239], *Laricobius erichsonii* Rosenh. [*cf.* **42** 280] and *Scymnus* (*Pullus*) *impexus* Muls. [*cf.* **42** 250] are established in south-western New Brunswick.

Proverbs (M. D.). **Effects of Temperature and Humidity on Toxicities of three Insecticides to Larvae of the Codling Moth (Lepidoptera: Oletheutidae).**—*Canad. Ent.* **89** no. 9 pp. 423–428, 4 refs. Ottawa, 1957.

The lead-arsenate sprays formerly used were less effective against *Cydia* (*Carpocapsa*) *pomonella* (L.) on apple in the South Okanagan Valley of British Columbia, where the climate is hot and arid and the growing season long, than in Ontario, where the climate is cooler and wetter and the growing season usually shorter, whereas sprays of DDT or methoxy-DDT (methoxychlor) give equal or superior control, and the effects of relative humidity and temperature on the toxicity of these three materials to the larvae was accordingly investigated in the laboratory in British Columbia in 1951–53. Individual apples, of which the calyx and stem depressions had been filled with paraffin wax, were sprayed with 50 per cent. wettable DDT at 0·02–0·1 g. per litre of water, 50 per cent. wettable methoxy-DDT at 0·08 g. or lead arsenate at 3 g., a section of wax paper bearing a developing egg from a laboratory stock of *C. pomonella* was pinned to the stem end of each when they were dry, and they were then kept at constant temperatures and humidities for a fortnight, when the number of larval entries was determined. The ranges of temperature and relative humidity tested were 70–90°F. and 45–100 per cent., respectively. There was no significant difference in the numbers of larvae that entered unsprayed fruits at high and low temperatures, and temperature and humidity did not measurably affect the toxicity of lead arsenate [*cf. R.A.E.*, A **31** 405]. The toxicities of DDT and methoxy-DDT were not greatly affected by relative humidity, whether the deposits had been weathered by exposure for one week in the orchard or not, unless the air was saturated, when they were considerably reduced, but when relative humidity was constant, both materials were more toxic at low than at high temperatures, with or without weathering. It is concluded that summer temperatures are less and rainfall more favourable for initial control of the larvae than in Ontario, but that both are probably of minor importance.

Baird (R. B.). **Notes on a Laboratory Infection of Diptera caused by the Fungus *Empusa muscae* Cohn.**—*Canad. Ent.* **89** no. 9 pp. 432–435, 7 refs. Ottawa, 1957.

A laboratory stock of Dipterous parasites of grasshoppers in Canada rapidly became infected with the fungus, *Entomophthora* (*Empusa*) *muscae*, following the accidental introduction of infected field-collected adults of *Sarcophaga* (*Servaisia*) *aculeata* Aldr. Symptoms, which are described, appeared first in laboratory-reared flies (species not recorded) 15 days after the infected field-collected parasites had died and six days later in *Sarcophaga* (*Kellymyia*) *kellyi* Aldr. The disease was transmitted under controlled conditions to *Agria* (*Pseudosarcophaga*) *affinis* (Fall.) and *Musca domestica* L. caged with newly dead, infected parasites. It increased in virulence with increased passage through insect hosts, but became inactive, for reasons not understood, when transferred to another room with similar conditions of temperature and humidity. Larvae dissected from infected females of *S. kellyi* were found not to be infected. The spread of infection in the laboratory was stopped by the removal of all parasites that were infected or had been exposed to the disease, the adoption of aseptic techniques, and the use of cages with covers of cheesecloth, the loose fibres of which apparently prevented the entry of the conidiospores, instead of plastic screening.

Monro (H. A. U.). **Eradication Measures against the Oriental Fruit Moth in the Province of British Columbia, Canada.**—*FAO Plant Prot. Bull.* **6** no. 12 pp. 177–179, 2 refs. Rome, 1958.

Cydia (*Grapholitha*) *molesta* (Busck) has never been recorded as established in British Columbia, although it is present in parts of Washington State, to the south. A quarantine is enforced by the Canadian government whereby fresh fruits imported into British Columbia must be subjected to fumigation with methyl bromide according to an approved schedule, unless they are accompanied by a certificate that they originate from a district free from the pest. In September 1956, living larvae of *C. molesta* were found in peaches brought to a cannery at Summerland, in the Okanagan fruit-growing district of British Columbia, from Yakima, Washington. The consignment was accompanied by a certificate of fumigation, but the treatment had apparently failed, the reason for which was not known. Before the finding of the larvae, débris from the processed fruits had been distributed as soil fertiliser throughout a neighbouring eight-acre peach orchard. Evidence was also obtained that infested peaches might have been despatched to another cannery at Osoyoos, refuse from which had been poured into settling pits or thrown on the municipal dump some miles away.

It was decided to fumigate all these possible foci of infestation with methyl bromide under tarpaulins. No moth development before the spring seemed likely, and treatment against hibernating larvae was selected. The two canneries were covered with tarpaulins of plasticised nylon and fumigated by the technique used in the campaign against the khapra beetle [*Trogoderma granarium* Everts] in the United States [*cf. R.A.E.*, A **45** 259]. Larvae of *Tenebroides mauritanicus* (L.), which were found to be four times as resistant to methyl bromide as hibernating larvae of *C. molesta*, were distributed as test insects, and complete mortality of these was obtained, indicating that any *Cydia* larvae present would likewise have been killed. The pits and dump at Osoyoos were also fumigated effectively.

Fumigation of the orchard was required to be completed by mid-April, when it was calculated that adult emergence would be likely. Air and soil temperatures were too low before mid-March, so that the period available was only one month. Possible sites in which larvae might have spun cocoons comprised crevices on the rough bark of trees, up to a height of about a foot, weed stems, soil trash, orchard boxes, cracks in and around buildings, and cracks in the soil down to a depth of about an inch. The trees were cut down in late winter to a height of about a foot and burned, and the tarpaulins, usually 50 ft. square, were clamped together to cover areas of 1 acre, or later smaller areas, which were more easily treated, and their outer edges buried in trenches 6 in. deep. Caps were placed on the stumps to prevent damage to the tarpaulins, and the latter rested on these and on orchard boxes placed at intervals, to prevent sagging and provide head space for even distribution of the fumigant. The amount of methyl bromide used was five tons, the average dose applied 23·3 lb. per 1,000 sq. ft., and the mean concentration sustained in the free space for the first 24 hours of each treatment 22·3 oz. per 1,000 cu. ft. The soil temperature at a depth of 1 in. was 33–51°F. Larvae of *T. mauritanicus* were again used as test insects, and the results obtained indicated that all larvae of *C. molesta* would have been destroyed, down to a depth of 2 in. below the soil surface. The work was completed by 10th April.

After the fumigation was over, the surrounding orchards were sprayed with DDT, and trapping for adult moths was organised throughout the Okanagan fruit-growing area. None had been taken by the end of the season, and no reports were received of the presence of any stage of the insect. However, trapping was to be continued for several years.

Puzzi (D.) & Orlando (A.). **Progress on Fruit Fly Control in São Paulo, Brazil.**—*FAO Plant Prot. Bull.* **6** no. 12 pp. 184–188, 3 figs., 11 refs. Rome, 1958.

Ceratitis capitata (Wied.) and *Anastrepha mombinpraeoptans* Seín are the principal fruit-flies infesting orchards in São Paulo. The former is largely associated with coffee [*cf. R.A.E.*, A **44** 29], and the latter with peach, medlar, persimmon and other fruits; both attack *Citrus*, the composition of the population depending on the other fruits in the vicinity. Investigations showed that a 5–7 per cent. solution of brown sugar was the best attractant for use in bait-traps against the adults, and although these proved ineffective for control, they are useful for ecological and other studies. Bait-sprays offer the best promise of control, and a new method was devised for comparing attractants for use in them. Petri dishes with three invaginated holes 8 mm. in diameter in the covers were sprayed on the inside with the attractant to be tested and left to dry, after which 2–3 were hung in coffee trees. Protein hydrolysates were found in this way to be powerful attractants, and sugar-cane molasses to be the best of the inexpensive products available. A hydrolysate of concentrated maize steep liquor, which was found to contain 17 amino acids, was the best of the hydrolysates tested against *C. capitata* and cheaper than yeast formulations [*cf.* **47** 9, etc.]. In orchard tests, bait-sprays of 0·1 per cent. dieldrin, 0·2 per cent. malathion or 0·02 per cent. parathion, all with 5 per cent. molasses, applied fortnightly or at shorter intervals to one side of each tree at an average rate of about 22·5 gal. per acre gave 97 per cent. reduction of the adult population over large areas, but were unsatisfactory in small ones owing to continuous immigration of flies from without. Soil treatment with aldrin to control emerging flies is a useful auxiliary measure [*cf.* **45** 366].

Jacobson (M.). **Insecticides from Plants. A Review of the Literature, 1941–1953.**—*Agric. Handb. U.S. Dep. Agric.* no. 154, [4+] 299 pp., 236 refs. Washington, D.C., 1958.

The literature reviewed consists of all that published in 1941–53 in which plant parts are recorded as having been tested for toxic or repellent properties for insects, excluding that dealing with pyrethrum, rotenone or nicotine. The plants are grouped by families, and notes on the results and references to the sources of the information are given for each. Over 3,000 species are represented, and an index to them is included.

Schwenke (W.). **Zur Bionomie und Gradologie des grossen braunen Rüsselkäfers *Hylobius abietis* L. Mit Bemerkungen über die Artbestimmung und Verbreitung von *Hylobius abietis* L. und *H. pinastri* Gyll.** [On the Bionomics and Population Increase of *H. abietis*. With Notes on the specific Determination and the Distribution of *H. abietis* and *H. pinastri*.]—*Beitr. Ent.* **6** no. 3–4 pp. 245–273, 5 figs., 22 refs. Berlin, 1956.

Hylobius abietis (L.) has increased in importance as a pest of young conifers in many parts of Europe since the late war, as a result of large-scale felling and replanting of pine and spruce. It breeds in stumps, and the adults damage living trees by gnawing the bark. *H. pinastri* (Gylh.) causes similar injury to pine and has frequently been confused with *H. abietis*. Characters are given differentiating these two weevils, with notes on their

distribution and that of other European species of the genus, and investigations carried out in 1954–56 on the bionomics and frequency of *H. abietis* in two pine forests near Berlin are described. The methods adopted comprised catching the adults in short trap trenches arranged in various ways, investigation of stumps, and shaking the weevils from the trees on to cloths spread beneath them. Almost the only stumps available were in thinned stands of pines up to about 35 years old.

The results showed that development of a generation of *H. abietis* required two years [*cf.* *R.A.E.*, A **13** 63], the newly emerged adults apparently remaining in the stumps to overwinter. They had previously been known to overwinter only in the soil, and specially favourable conditions in the stumps are held to have been responsible for their unusual behaviour. In one of the forests, which was of the *Vaccinium*-type [*cf.* **41** 338], adults were taken mainly from April to July in 1954 and from May to June in 1955, being most numerous in May in each year, but in the other, which was of the lichen-type and in which observations were begun only in 1955, the rate of emergence from the stumps remained fairly high from May to July. The difference may have been due to slower development or to a longer rest period in the lichen-type forest, owing to lower ground temperatures. The weevils appeared to be more abundant in the second type of forest. For feeding [*cf.* **21** 669, etc.], the adults showed no preference between trees 1–5 or 6–10 years old, but hardly any were present in the crowns of trees over 15 years old. Males and females occurred in about equal numbers, males predominating in April–May and females thereafter, and 7·8 per cent. of the adults were found by examination of the state of the elytra to have overwintered more than once. The trench catches suggested that flight [*cf.* **21** 23] was dependent on light intensity but continued independently of it when once begun, so that when leaving a stand, the weevils reached its edge by crawling and then took flight, but did not cease flying when entering one. They flew principally from east to west, against the prevailing wind. The females oviposited mostly on freshly cut stumps, less frequently on those of trees felled one year previously and hardly ever on older stumps. A maximum of 60 larvae per stump was recorded, the number varying with stump size. Mortality was low during the first year of larval development, being only about 5·5–8 per cent. by the first winter, but was high thereafter. Whereas the numbers of larvae per stump in the winter of 1954–55 averaged 12·4, the average number of newly emerged adults the following winter was only 1·4. No parasitism was observed, but fungi attacking the stumps were responsible for some of the mortality.

Narayanan (E. S.), Subba Rao (B. R.) & Gangrade (G. A.). **The Biology and Rate of Reproduction and the Morphology of the immature Stages of *Apanteles angaleti* Muesebeck (Hymenoptera: Braconidae).**—*Beitr. Ent.* **6** no. 3–4 pp. 296–320, 30 figs., 16 refs. Berlin, 1956.

Apanteles angaleti Mues. [*cf.* *R.A.E.*, A **45** 378], which is widespread in India, was first observed parasitising the larvae of *Platyedra gossypiella* (Saund.) on cotton at New Delhi. It was reared in the laboratory on larvae of *Corcyra cephalonica* (Stnt.) by a technique that is described, the principal feature of which was the maintenance of a high relative humidity (about 90 per cent.) in the oviposition cages, and several thousands were shipped to the United States for release against *P. gossypiella* there [*cf.* **46** 352, etc.]. The eggs and larvae of *A. angaleti* are described, with special reference to the respiratory system, and observations on its bionomics in the

laboratory are recorded. The females usually laid only one egg in each *Corcyra* larva, but up to five were observed; only one parasite larva survived in each host. The average duration of the egg stage ranged from 32·2 hours at 25°C. [77°F.] to 24·9 at 35°C. [95°F.], and 70 per cent. relative humidity, but larvae that hatched at 35°C. did not survive. When the parasite larva reached the end of the second instar, the host larva spun a cocoon; the parasite then left the host, moulting in the process, fed on its body juices, and spun its own cocoon soon after within that of the host larva, pupating about 1–2 days after emerging from the host. When the latter failed to spin a cocoon, the parasite either failed to leave the host or left it but spun no cocoon and died. At 30°C. [86°F.] and 70 per cent. relative humidity, the first and second larval instars lasted 15·8–20 and 8·5–13·2 days, respectively, and the pupal stage 4–6 days. When fed on freshly cut raisins, adult males and females lived for 2–8 and 7–12 days, respectively. Pairing took place soon after emergence, and the average total number of eggs laid per female increased from 61·83 to 100·83 when the number of host larvae provided daily was increased from 10 to 20 for each female, but was only 86·33 when 30 per day were provided. The ratio of males to females averaged 1:2 in counts of the progeny of individual females, 1:1·6 in mass rearing conditions and nearly 1:1·4 in counts of adults emerging from material collected in the field.

Niklas (O. F.). **Die Erzwespe** *Tetracampe diprioni* **Ferrière als Eiparasit der Kiefernblattwespe** *Neodiprion sertifer* **Geoffr. (Hym.: Chalcidoidea—Hym.: Tenthredinidae).** [*T. diprioni* as an Egg-parasite of *N. sertifer*.] —*Beitr. Ent.* **6** no. 3–4 pp. 320–332, 10 figs., 15 refs. Berlin, 1956.

During three years' investigations on the ecology and biological control of *Neodiprion sertifer* (Geoffr.) on pine near Darmstadt, a few of the eggs were observed each year to be parasitised by *Tetracampe diprioni* Ferrière. *N. sertifer* overwinters in the egg stage and has one generation a year [*cf. R.A.E.*, A **43** 143], and eggs laid in 1954 were taken at regular intervals and examined in the laboratory in order to investigate the bionomics of the parasite. Records of the occurrence of *T. diprioni* are reviewed from the literature, all stages of this Eulophid and the development of the egg of *N. sertifer* are described, and the dates of occurrence of the parasite and host stages concerned and the average daily temperatures are shown in a diagram. *N. sertifer* oviposited between the beginning of September and mid-October, and eggs of *T. diprioni* were laid throughout this period, but the total parasitism reached only 0·5 per cent. The parasite larvae had completed their development by the end of November, when average daily temperatures fell below 5°C. [41°F.], and pupation began when they rose above 5°C., in mid-March. Adult emergence began at about the end of April in the field and was completed between 12th April and 23rd June in the laboratory, adults developing in the same egg mass emerging on the same day. The ratio of males to females was 1:2·2, and mortality of the parasite within the host eggs was 7·8 per cent. at the end of April. Development of unparasitised eggs of *N. sertifer* was interrupted [*cf.* **46** 404] during January–February, when temperatures of under 0°C. [32°F.] predominated, and hatching began in mid-April. *T. diprioni* has been observed elsewhere to have a summer generation on certain other sawflies during the period in summer when no eggs of *N. sertifer* are available, but none of these was present in the area of the investigations, and the way in which the adults survived during the summer was unknown. The absence of an alternative host is considered to account for the low population of the parasite [*cf.* **43** 143].

Niklas (O. F.). **Die Buckelfliege** *Megaselia rufipes* **Meig. als Parasit bei Maikäferengerlingen und -puppen** (*Melolontha* **spec.) (Diptera: Phoridae—Coleoptera: Scarabaeidae).** [*Megaselia rufipes* as a Parasite of the Larvae and Pupae of *Melolontha* sp.]—*NachrBl. dtsch. PflSch-Dienst* **9** no. 3 pp. 33–36, 3 figs., 20 refs. Stuttgart, 1957.

In further investigations on biological factors of control affecting *Melolontha* in western Germany [*cf. R.A.E.*, A **46** 290], larvae and pupae collected from the soil in forest areas were brought into the laboratory between 23rd April and 10th November 1955 and the apparently healthy ones reared as before. Adults of *Megaselia rufipes* (Mg.) emerged from some of them, and all but one of the parasitised individuals were from the neighbourhood of Lorsch [*cf. loc. cit.*]. The Phorid is only occasionally parasitic, and this is the first known record of it from *Melolontha*. Its other recorded hosts and the varied vegetable and animal refuse and other materials on which it also breeds are reviewed, and notes are given on the morphology of all stages. Parasitised individuals were found between 1st July and about the end of August and reached a maximum shortly before the end of that month. They comprised 3·9 per cent. of the total collected in this period, and the percentage increased with the stage of development of the host from 1·2 for first-instar larvae to 7·1 for pupae. One third-instar larva examined was found to contain 42 full-fed *Megaselia* larvae, and another contained so many eggs and larvae of the parasite that it must have been attacked by more than one female. The parasite larvae emerged from their hosts between 5th August and 12th September, 8–36 days after collection, and the numbers doing so reached a maximum at the beginning of September. They usually pupated within 24 hours, and the numbers of puparia resulting from larvae emerging from each of eight third-instar hosts were at least 19–23. Adults emerged between 20th August and 8th October, the numbers reaching a maximum at the beginning of October. The pupal stage lasted 16–27 days, with an average of 22, at 22°C. [71·6°F.] and 70 per cent. relative humidity, and, under these conditions, the adults lived for 16 days when honey was provided. Oviposition occurred when second-instar larvae in moist sawdust were offered them. The females evidently lay their eggs on and not in the larvae, as they have no ovipositors; it was not known whether they also oviposit on the pupae, or whether the parasitised pupae found had been attacked in the larval stage. None of the dead or injured individuals collected was parasitised by *Megaselia*, nor were larvae of other Lamellicorns that were collected at the same time.

Tachikawa (T.). *Metaphycus tamakatakaigara* **sp. nov., an important Parasite of** *Lecanium kunoense* **Kuwana in Japan (Hym., Encyrtidae).** —*Akitu* **6** no. 2 pp. 27–30, 2 figs., 6 refs. Kyoto, 1957.

Eulecanium (*Lecanium*) *kunoense* (Kuw.) is one of the most important insect pests of apple and stone fruit trees in Japan and Korea and has become established in California [*cf. R.A.E.*, A **36** 399, etc.]. The author reviews records of the five natural enemies of this Coccid hitherto known in the Far East, of which only *Chilocorus rubidus* Hope, in Japan, affords much control, and gives descriptions of the adults of both sexes of *Aphycus* (*Metaphycus*) *tamakatakaigara*, sp.n., which was found in 1956 parasitising the Coccid at Matsuyama, Shikoku, followed by notes on characters distinguishing it from closely related species. *E. kunoense* has only one generation a year at Matsuyama, the overwintered nymphs becoming adult during the latter part of April and eggs being laid mostly in May, and the larvae

of the Encyrtid overwinter in the immature Coccids, complete their feeding on the internal organs in spring and give rise to adults from late April. Females were over twice as numerous as males.

Lowe (A. D.). **Effect of "Metasystox" on the Cabbage Aphid** (*Brevicoryne brassicae* (**L.**)).—*N.Z. J. agric. Res.* **1** no. 1 pp. 37–43, 1 ref. Wellington, N.Z., 1958.

Observations on the effect of sprays of Metasystox [dimethyl 2-(ethylthio)-ethyl phosphorothioate (methyl-demeton)] on *Brevicoryne brassicae* (L.) and its natural enemies and on the risks to operators applying them were made in New Zealand during an experiment already described in which this material was applied by aircraft to marrow-stem kale (chou moellier) on 16th October 1956 at a rate affording at least 16 fl. oz. per acre [*R.A.E.*, A **46** 373]. The experiment was performed in an isolated field, the whole of which was treated, but the spray swathes failed to overlap at one or two small areas at the margins and these were used as controls. Counts of the aphids made daily for three days after treatment and subsequently at intervals over about 50 days (until harvest) showed that mortality after treatment was complete and that the plants remained free from infestation, though their freedom was attributed in part to the isolated situation of the field, which protected them from reinfestation during the period of spring flight in late October. Some evidence was obtained from the unsprayed areas that infestation would have become very severe in the absence of treatment. Observations on natural enemies of the aphid showed that the parasites, *Charips* (*Allotria*) *brassicae* (Ashm.) and *Diaeretus* (*Aphidius*) *rapae* (Curt.), of which the second was the more numerous, and the predator, *Coccinella undecimpunctata* L., which was mostly in the adult stage at the time of application, were little harmed, but larvae, though not adults, of *Syrphus novae-zealandiae* Macq. were killed by direct contact. Operators and sampling personnel moving through the crop developed no severe symptoms after limited deliberate exposure, but the use of protective clothing is advised where exposure is likely to be prolonged.

Papers noticed by Title only.

Barber (H. G.). **Insects of Micronesia. Vol. 7 no. 4. Heteroptera: Lygaeidae.**—pp. [3+] 173–218, 11 figs., 1 map. Honolulu, Bishop Mus., 1958. Hardy (D. E.). **Vol. 13 no. 2. Diptera: Omphralidae (Scenopinidae).**—pp. [5+] 11–13, 1 fig., 1 map. de Souza Lopes (H.). **Diptera: Sarcophagidae.**—pp. 15–49, 14 figs. 1958. [*Cf. R.A.E.*, A **43** 345; **47** 40.]

Zimmerman (E. C.). **Insects of Hawaii. A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on their Origin, Distribution, Hosts, Parasites, etc. Volume 7. Macrolepidoptera.**—ix [+3+] 542 pp., 426 figs., 30½ pp. refs. Honolulu, Univ. Hawaii Press, 1958. Price $9.50. [*Cf. R.A.E.*, A **46** 360, etc.]

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